# FARM KNOWLEDGE

## What Every Farmer Wants to Know

Wagons, Automobiles, Motor Trucks, and Tractors
Farm Machinery for Tillage, Planting, Harvesting, Etc.
Farm Power, Its Sources and Application
Drainage, Irrigation, and Other Engineering Problems
Farm Buildings, Their Design, Construction, and Equipment
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The Science of Farming in Simple Terms
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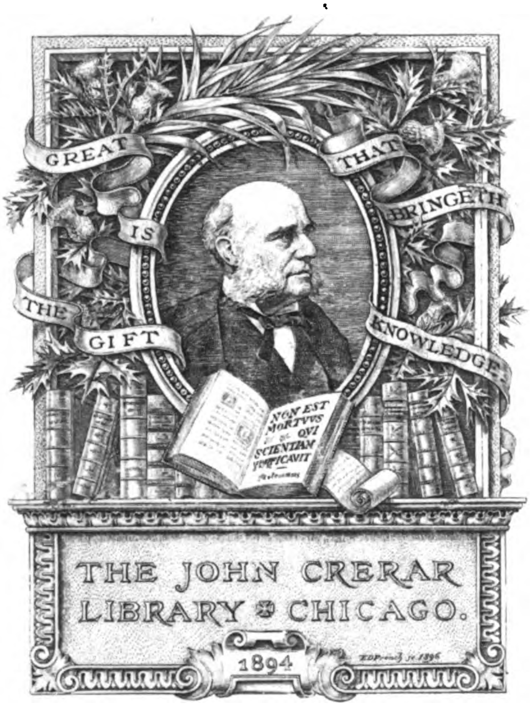
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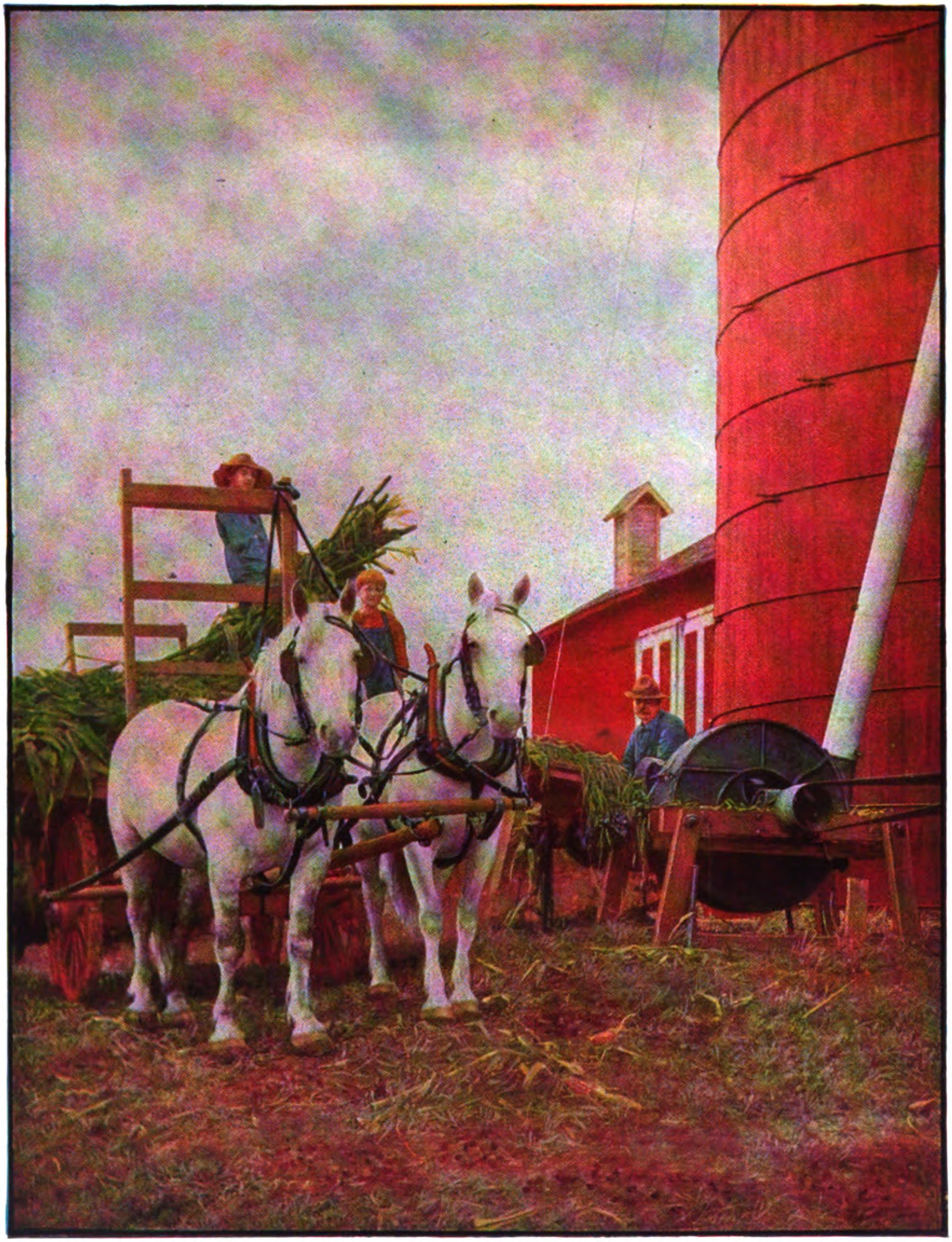
# FARM KNOWLEDGE



THE FARMER'S WORTH is measured by his results. His results depend largely upon the ability with which he judges, buys, uses, and takes care of his equipment. In the marvellous development of agriculture throughout the ages, no factor has been more important than the invention and perfection of improved tools, implements, buildings, and machines.

# FARM KNOWLEDGE

*A Complete Manual of Successful Farming Written by Recognized Authorities in All Parts of the Country; Based on Sound Principles and the Actual Experience of Real Farmers—"The Farmer's Own Cyclopedia"*

EDITED BY
E. L. D. SEYMOUR, B. S. A.

IN TWO VOLUMES

*VOLUME II—PART I*

## *FARM IMPLEMENTS AND CONSTRUCTION*

**The Selection and Use of Vehicles, Implements and Farm Machinery; Farm Power and Its Applications; The Principles and Practices of Farm Engineering; The Arrangement, Design, Construction and Equipment of Farm Buildings**

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# FARM KNOWLEDGE

## VOLUME II—PART I

## FARM IMPLEMENTS AND CONSTRUCTION

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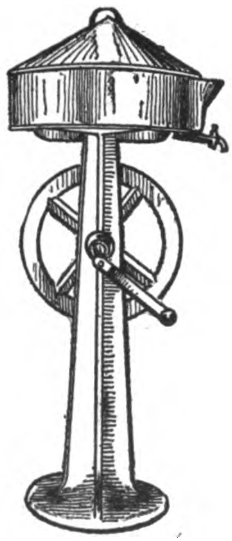
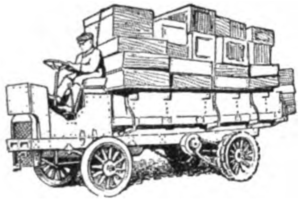


The original Babcock tester

# FARM KNOWLEDGE



## PART I

# Farm Vehicles

IT IS common knowledge that the materials with which the farmer carries on his work are plants, animals, and the soil. It is less generally realized, or at least appreciated, that in using them, the farmer has to practice in no small degree the applied sciences of mechanics and engineering. This is a condition of relatively recent growth. For many years farming retained its early simplicity; practically all its tasks were accomplished by hand or horse or ox power with the help of crude, cumbersome tools. The muscles of man largely measured the magnitude of his accomplishments and consequently his agricultural success.

But times have indeed changed. Analytical and inventive genius have applied themselves to the problem of creating machines to do farm work—both because man power is becoming scarce, and in order that the farmer might employ less of his energy in manual labor and more in mental achievement and planning. New standards of living have arisen to make farmers ready and anxious for more comforts and conveniences in their homes and barns—and better buildings in which to install them. Modern investigations have discovered, simplified and perfected engineering methods for improving soil conditions and reclaiming waste lands. All these developments have not only offered the farmer new opportunities, but have also demanded of him new abilities, and shouldered him with new responsibilities. To-day the most successful farmer is not he who can cradle the most grain or build the smoothest hay stack, milk the most cows in a day or work best side by side with his hired hands; rather it is the man who has the most complete and best cared for outfit of farm machinery; who can run and repair the most efficient power plant; who can design and construct the most economical barn or poultry house; who can most effectively drain a marshy meadow or irrigate a leachy, drought-ridden slope. There is no industry to-day (outside of those that are essentially and technically mechanical) that makes such varied and extensive and important use of mechanical and engineering principles. It is for this reason that the entire present volume is devoted to the different phases of this subject.

These fall into five groups as shown in the index: first, Vehicles, including the tractor (which is that and much more); second, Machinery; third, Power, where to get it and how to use it; fourth, what may be called the Civil Engineering of the farm; and fifth, the Design, Construction, and Equipment of Buildings, from the dwelling to the least of the wagon sheds and farm ice houses. Since there are many professional men whose sole interests lie along one or another

of these directions, it is not to be expected that the farmer—who as such is a specialist in a very complex and different industry—will become an expert in all, or any one of them. But as he becomes reasonably familiar with their principles and methods, he is becoming ever more independent, better equipped, and more assured of ultimate success and prosperity.

The wide range between a one-horse light runabout or a dump cart and a six-cylinder touring car, a three-ton truck or a 40 H. P. gas tractor—each of which is no longer a mystery to many a real farmer—is but one illustration of the diversity of interests and abilities that marks the twentieth century tiller of the soil. —EDITOR.

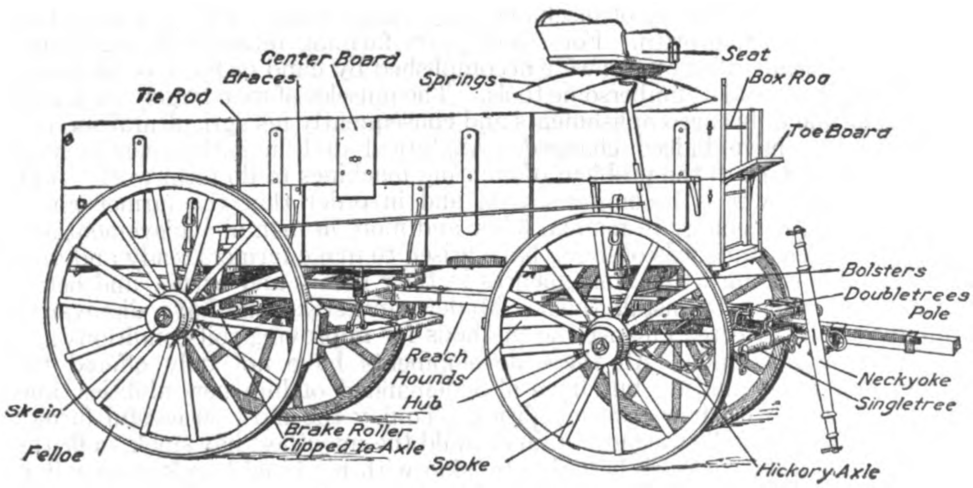



FIG. 1. Typical heavy farm wagon.

# CHAPTER 1

# Horse-Drawn Work Vehicles for the Farm

*By* E. W. LEHMANN, *Professor of Agricultural Engineering, University of Missouri, who was born on a farm in southern Mississippi and lived there until he entered college. Since then he has given his summers to practical farm work and now owns a half interest in a farm adjoining the old home place. His technical experience and teaching have taken him to the agricultural colleges of Mississippi, Texas, Iowa, Wisconsin, Cornell, and Missouri, where he has become familiar with the mechanical features of the problems with which he is equally well acquainted as a practical farmer.*

*The farm wagon is so common an implement that the average person takes it for granted, and fails to realize the value of scientifically correct design and construction. This chapter throws a new light on the subject, and should enable the farmer to get better value for his money, both in buying and keeping his work vehicles.*—EDITOR.

THOUSANDS of years ago man had few possessions, and, therefore, very little need of vehicles. As he acquired clothing, weapons, and other possessions, and as he changed his place of residence, some means of transportation became necessary. It was probably some hunter who created the first vehicle when he found how much easier it was to drag his game home on a branch of a tree than to carry it on his back. Another hunter, accidentally or otherwise, may have placed a round stick under his sled and thus started the idea of a wheel, which is the basis of all our systems of transportation. There was a gradual development from this roller device to the wooden wheel made of a sawed off section of the trunk of a tree with a hole in the centre to receive the axle. But it was the early Egyptian who perfected the spoked wheel.

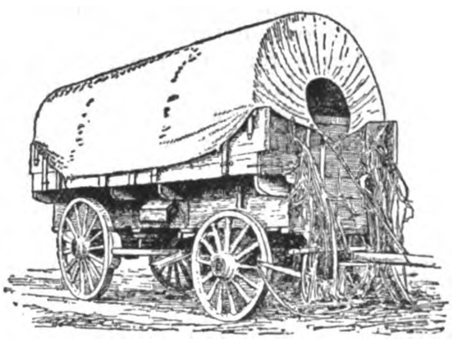


FIG. 2. Prairie schooner

Improved roads in every country have produced great changes in types of vehicles. The early Roman road especially made possible a great advance. In all cases the development of methods of transportation follows the settlement of a country. Before roads were built in America, the early settler hauled all his equipment and household effects on pack horses over bridle paths through the forests. Only on the introduction of the stage coach and heavy wagons for hauling freight were the turnpikes and state and toll roads built.

As farmers acquire more modern types of vehicles the country roads are steadily improved. But there are still backward sections of the United States where instead of wheeled vehicles, sleds, called "slides," are still used. In parts of the South, negroes use on the farm crude wooden wagons, which represent an improvement over the slide, but of which the wheels, like those of the wagons of past ages, are disks cut from the trunks of large trees. The black gum being very tough wood, and not splitting easily, is well suited for this purpose. These wagons are made entirely of wood except for the linchpins (usually large nails) that hold the wheels on the spindle.

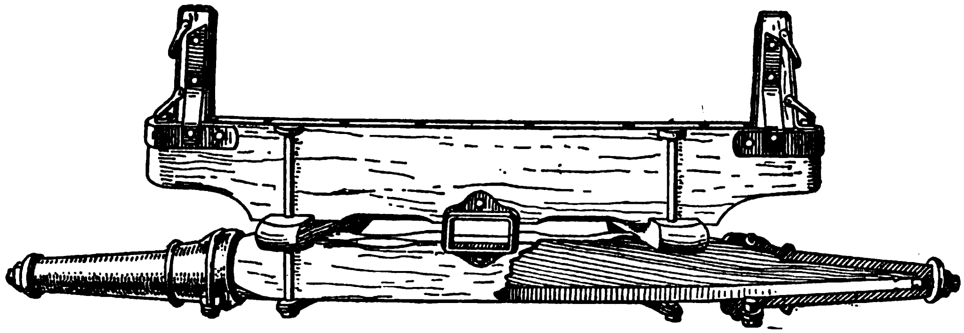


FIG. 3. Thimble skein hind gear, a sectional view of part of it showing axle reinforcement

The stone-boat originated in the eastern states, where it was used in clearing fields of stones. For moving plows, harrows, materials for concrete or masonry work, barrels of spray mixture and other heavy or bulky articles about the farm it is more convenient than a wagon. Its frame should be of 2 x 4s (for runners) with boards fastened across and the hitch fastened to one end. A better boat is made by cleating heavy planks together lengthwise and bolting them at the front end to a special metal head made for the purpose with bolt holes and one for the hitch. A wagon with a platform hung below the axle is an improvement on a stone-boat for some purposes.

The modern wagon has been developed to meet a need that exists on practically every farm. Because it is used more throughout the year than any other farm implement (to give only one reason), every farmer should know something about the construction and essential points of a well-made wagon.

**Materials for wagon construction.** The durability and strength of a wagon depend to a large degree on the materials of which it is made. Every well-built wagon is made of selected, air-dried materials, air-drying or seasoning of lumber requiring about 3 years. Lumber that is dried rapidly in a kiln is not uniformly cured, is usually more brash, and will not resist as great a shock or strain as air-dried material. Black birch or white oak is usually used for hubs; white oak for spokes, felloes, bolsters, sand boards and hounds; hickory is used for axles in the best wagons, but because of the high price of the best grades, some makers use maple, oak or cheaper grades of hickory. If the wooden parts are soaked in linseed oil before being assembled, they will not shrink and decay when exposed to the weather as readily as if untreated. All metal should be of a good grade of mild steel and all parts of ample size to give strength. Nearly every wagon is built to carry a certain load which is specified as its *capacity*. The capacity ratings of a reputable firm are an aid to the farmer in selecting a wagon for a particular service.

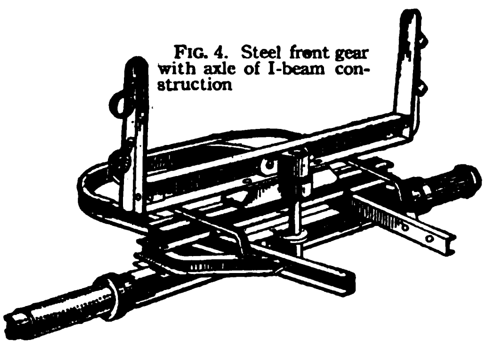


FIG. 4. Steel front gear with axle of I-beam construction

## Draft of Wagons

**Height of wheels.** The nature of the road bed is the biggest factor affecting the pull required to move a wagon. Features of construction which affect its draft are the height of the wheels, the width of the tires and the efficiency of the bearings. The following tests (made at the Missouri Agricultural Experiment Station) compare the draft of a 2,000-pound load on high, medium, and low wheels on different road surfaces. The

heights of the wheels were as follows: the high, 44 inches (front) and 56 inches (rear); the medium, 36 inches (front) and 40 inches (rear); the low, 24 inches (front) and 28 inches (rear); the wheels were of steel with 6-inch tires. The figures represent pounds of pull required per ton of load.

| ROAD SURFACE | WHEELS | | |
|---|---|---|---|
| | HIGH | MEDIUM | LOW |
| Macadam; slightly worn clean, fair condition . | 57 | 61 | 70 |
| Dry gravel road; sand 1 inch deep; some loose stones . . . | 84 | 90 | 110 |
| Earth road; dry and hard . . . . . | 69 | 75 | 99 |
| Earth road; thawing; half inch sticky mud. | 101 | 119 | 139 |
| Timothy and bluegrass sod, dry, grass cut . | 132 | 145 | 179 |
| Timothy and bluegrass; wet and spongy . . | 173 | 203 | 281 |
| Corn field; flat culture across rows, dry on top . . . . . | 178 | 201 | 265 |
| Plowed ground, not harrowed; dry and cloddy . . . . | 252 | 303 | 374 |

While the results are in favor of the high wheels there are other factors which would determine the height to select. The medium height is generally preferred as it is more convenient.

**Tires.** The effect of the width of the tire on draft is shown in the following table (from Bulletin 39, Missouri Experiment Station). The wheels used were of the same height and provided with 1½-inch and 6-inch tires. Again the figures are pounds of pull required per ton of load.

| ROAD SURFACE | WIDTH OF TIRE | |
|---|---|---|
| | 1½-INCH | 6-INCH |
| Broken stone road; hard, smooth; no dust . . . . . | 121 | 98 |
| Gravel road; hard and smooth . . . . | 182 | 134 |
| Gravel road; wet, loose sand, 1 to 2½ inches deep . . . . . | 246 | 254 |
| Earth road, loam; dry dust, 2 to 3 inches deep . . . . . | 149 | 109 |
| Earth road, loam; dry and hard; no dust . | 90 | 106 |
| Earth road, loam; stiff mud, dry on top, spongy underneath | 497 | 307 |
| Earth road, clay; sloppy mud 3 to 4 inches deep; hard below . . . . . | 286 | 406 |
| Earth road, clay; stiff, deep mud . . . | 825 | 551 |
| Plowed land harrowed smooth and compact . . . . . | 466 | 323 |

The summary of the results of these experiments states that the wide tire gave lighter draft except under the following conditions: (a) when the earth road was muddy, sloppy and sticky but firm underneath, (b) when the mud was deep and stuck to the wheels, (c) when the road was covered with deep, loose dust, and (d) when the road was badly rutted with the narrow tire. Another very important advantage of the wide tire is that it does not destroy the road surface as rapidly as the narrow tire.

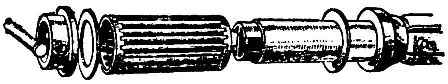


FIG. 5. Parts of a roller bearing

**Bearings.** The efficiency of the bearings in relation to draft is usually a small factor. However, all wagon spindles should be properly greased at intervals. The draft is slightly greater for large axles than for the small ones. Some manufacturers are reducing the axle friction by means of ball and roller bearings. The fact that such bearings are being used so efficiently in tractors and automobiles leads one to believe they should be equally efficient in a wagon.

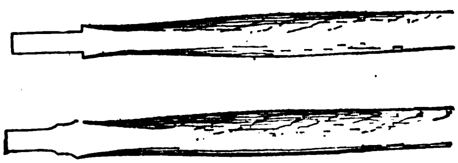


FIG. 6. Two types of spokes: *above*, regular spoke with square tenon; *below*, Milburn spoke with double slope shoulder tenon.

**The strength of a wagon.** Every well-built wagon is designed to resist hard usage. All parts should be made of ample size and strength. All irons should be attached to resist strains instead of merely for looks, and in a way that will not weaken the wooden parts. Clips are much better than bolts and should be used whenever possible. In building a wagon to suit the needs of a particular locality, the local conditions must be kept in mind. Different sorts of wagons are built for mountainous and prairie sections.

## Wagon Construction

(See page 11 for standardized schedule)

**The wheels.** The wheel is the most important part of a wagon. It is probably the first part to break in a poorly built wagon and the most expensive to repair. The hub is the heart of the wheel. There is a great deal of discussion as to the relative merits of oak and black birch for hubs, but both are well suited to this use if properly handled. Black birch does not check as badly as oak but is claimed to be more liable to dry rot. The common type of hub is turned to proper shape and given a severe heat test. It is then mortised to receive the spokes, after which heavy iron bands are forced on. Forcing the bands on cold is the best practice, since the wood is then not charred. Next the spokes are dipped into glue and forced into the hub. Most failures in wheels are at the point where the spokes enter the hub. There are two types of spokes—that with a double slope shoulder tenon and that with a square tenon. The former is said to be much stronger and more durable. It does not matter greatly whether the felloes are bent or sawed, but they should be well doweled and the tire bolted to them. A rivet should be placed on either side of each spoke to prevent splitting. Tires should be heavy and for the average farm wagon not less than 2 or 3 inches wide; the 4-inch tire is growing in favor. All tires must be oval-edged. When the tires are shrunk on the wheel the spokes are sprung slightly; this is called dishing the wheel. To make all the wheels uniform when the spokes are forced in they are given a little dish, and when the tire is shrunk on it adds to the dish.

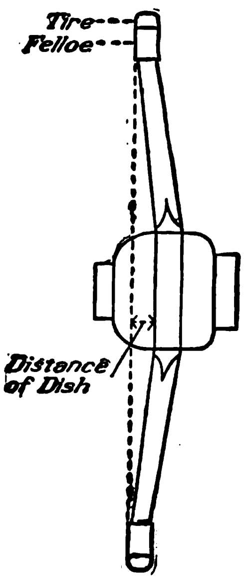



FIG. 7. The dish is the essential feature of wheel construction.

A type of wheel used on both wagons and buggies is known as the Sarven patent wheel. A great many more spokes are used in it than the ordinary wood hub wheel and these are driven so as to form a solid arch around the entire hub. The hub is covered with metal flanges, the two sides being bolted together with eight or ten bolts. The metal covering protects the hub and prevents its decay. This type of wheel is very strong; the schedule permits its use only on steel axles such as are used for western trade.

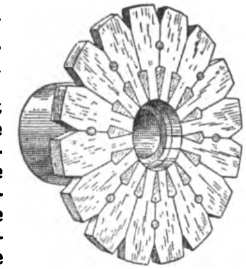


FIG. 8. Section of hub of a Sarven patent wheel

In the carrying out of the plan for the standardizing of wagons, there were adopted recommendations made by the United States Department of Agriculture after much experimentation. These had to do with the widths of tires and the diameters of skeins for wagons of the different standardized classes and capacities. The dimensions finally decided upon are as follows:

| TYPE AND CLASS OF WAGON | | CAPACITY (Lbs.) | TIRES (IN.) WIDTH | TIRES (IN.) THICKNESS | DIAMETER OF SKEIN (IN.) |
|---|---|---|---|---|---|
| Class A. Farm Wagons and Gears | Light | 1,500 | 2, 3 or 4 | ½ to ⅞ | 2¾ |
| | Medium | 3,000 | | | 2⅞ |
| | Standard | 4,500 | | | 3¼ |
| | Heavy | 6,000 | | | 3½ |
| Class B Valley Wagons and Gears | Medium | 3,000 | 2, 3 or 4 | ½ to ⅞ | 2⅞ |
| | Standard | 4,500 | | | 3¼ |
| | Heavy | 6,000 | | | 3½ |
| Class C Mountain Wagons and Gears | Light | 2,500 | 2, 3 or 4 | ½ to ⅞ | 2⅞ |
| | Medium | 4,000 | | | 3¼ |
| | Standard | 5,500 | | | 3½ |
| | Heavy | 7,000 | | | 3¾ |
| Class D One-horse Wagons and Gears | Light | 1,000 | 1½ to 4 | $\frac{5}{16}$ to ½ | 2¼ |
| | Medium | 1,250 | | | 2½ |
| | Heavy | 1,500 | | | 2¾ |

The standard heights for both wood and steel wheels for farm wagons are 40-44 inches and 44-48 inches. Wood wheels for trucks are to be made only 36 and 40 inches, and steel wheels for trucks only 28 and 32 inches.

**The axle.** The axle is another important feature in wagon construction since it is the site of many breaks. Axles are made of both steel and wood. There are several types of steel axles, the commonest three being the hollow, the solid square, and the I-beam. On account of the tubular shape of the hollow axle it will stand equally well a strain from any direction, and for this reason it is most desirable in hilly or mountainous sections. It is comparatively a light axle. The I-beam axle is of the same construction as the steel beams in structural work and is very strong. The greatest demand, however, is for wagons with wooden axles which are more

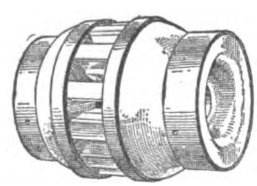


FIG. 9. Typical hub of wheel

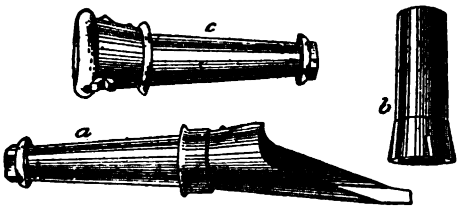



FIG. 10. Three types of skeins: a steel skein; b box; c cast skein

economical and which, according to manufacturers who build wagons with both steel and wooden axles, give lighter draft. Hickory is the best axle material. Wooden axles are provided with either cast-iron or steel skeins (that is, the sections which carry the wheels).

The cast-iron skein is used exclusively on wagons built for central, southern and eastern trade and the steel skein on wagons for western trade. The throat of the skein should be large so as to prevent the entrance of sand and dust into the boxing. The skein, sandboard, and bolster should be fastened to the axle with clips rather than bolts whenever possible. (Fig. 3.)

Many axles are provided with a steel truss that not only helps to carry the load but also holds the skeins in place. One of the best types of reinforcement is to have a bar of steel in a groove on the bottom of the axle. The end of the bar passes through the point of the skein and is finished to take a nut which holds the skein rigidly in place. (Fig. 3).

A proper "pitch" or set of skein is needed to overcome the effect of the dished wheels. The point of the skein is turned down until the supporting spokes are always vertical. To prevent the wheel from crowding out on the linchpin or axle nut the axle must be given some "gather." This means that the skein must be put on the axle so that the points of the skein are a little forward. The proper adjustment of the dish, set, and gather go a long way toward making a smooth-running, light-draft wagon. When the wheels are on, the set is measured by determining the difference in distance between the wheels at the top and at the bottom. This varies from 2½ to 3½ inches on the front gear and 3½ to 4½ inches on the rear gear for different sized skeins. The gather is measured

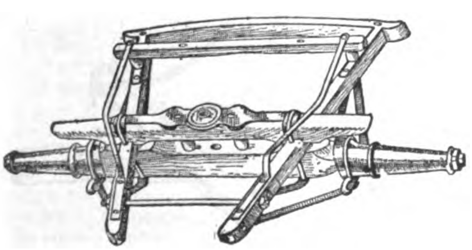


FIG. 11. Drop tongue front gear, with square hounds

as the difference in distances between the front and rear points on the wheel and is usually ½ inch on the front gear and ⅝ inch on the rear gear. In the modern wagon factory the skeins are forced on by powerful presses, and gauges are used to see that each skein is equally distant from the centre of the axle and has proper set and gather.

**Kinds of gears.** Only one gear with but one height of bolster is now made for each capacity of wagon. The front gear may be of drop, slip or coach-tongue type. Gears are made with either square or bent hounds. The square hounds are usually recommended because they are much easier to repair in case of an accident.

**Bolsters.** The bolsters should be well ironed to resist rough usage; if ironed full length on top, it is an advantage. They should be provided with suitable stakes rigidly fastened to them by irons. A suitable wearing plate should be provided between the sandboard and bolster on the front gear to

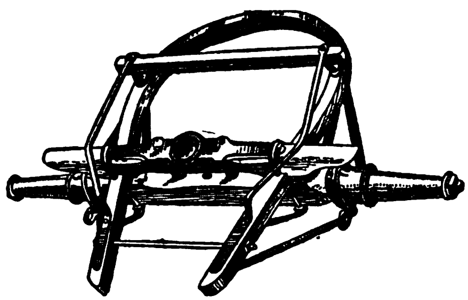


FIG. 12. Drop tongue front gear, with bent hounds, still in use in some localities

make turning easy. The new style cup and saucer bolster plate is one of the best types, and it takes the strain off the king bolt and prevents the sandboard from splitting. On some wagons a fifth wheel is provided between the bolster and sandboard. With a properly constructed fifth wheel the strain is better distributed between the front bolster and sandboard than with the old style, straight bolster plates. While there are many good features about the fifth wheel for use in wagons they have not come into general use.

**The reach** or coupling pole should be flexible and made of good, tough, straight-grained oak so that it will resist any strain when one wheel drops into a hole or rises over an obstruction. Reach boxes should be provided on wagons with wooden axles to prevent vibration and wear on the axle and sand bolster. The reach construction is restricted to the rectangular type only.

**Tongues** must also be made from tough, straight-grained timber and be both strong and elastic. The drop tongue is not as easily replaced as the stiff tongue. A special tongue and front gear is provided for working

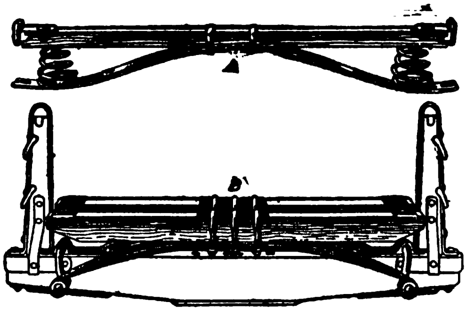


FIG. 13. Two types of spring bolsters: *a* one-horse single; *b* two-horse double

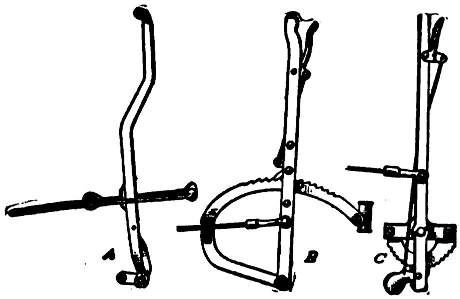


FIG. 15. Three types of brake levers: *a* Colorado foot lever; *b* Giesler handle; *c* Palla handle

oxen. When these are used the draft is from end of the tongue instead of from the front gear by traces and whiffletrees.

**The wagon box.** Wagon boxes are now made in one width only to fit between stakes set 38 inches apart, and are without foot boards. The sides and ends are best made of poplar, though some manufacturers use yellow cottonwood. Long-leaf pine makes a good bottom, but all bed sills should be of oak. All points on the bed where the bolster rubs should be ironed, and there should be a rub iron for the front wheel. The bed should be provided with rods and chains to prevent its spreading when heavily loaded.

The bed is often removed and the running gear used for hauling logs or lumber; or a special rack may be put on for hauling hay. It is such a task for a man or even 2 men to remove a bed and put on a heavy hay rack, that there has been developed a convertible wagon bed which is a great labor saver. (See Figs. 21, 22 and 23.) Such a bed must necessarily be well-braced and strongly built of the best material obtainable. A farmer who has a shop and is handy with tools could make such a bed during his spare time.

**Bolster springs.** It is a mistake that springs are so little used on farm wagons. Certainly all light wagons should be equipped with them, especially if the wagon is used in delivering garden truck, fruit, or other easily-bruised products. Springs lessen the effect of bumps, make possible faster driving and the hauling of a larger load, and give the driver more comfort and satisfaction. The two types in use are the coil and the leaf spring, the latter seeming to give better satisfaction.

**Brakes** are a necessity in hilly country. There are two types. The *box brake* is used most on light one- and two-horse wagons; the objection to this type is that it tends to weaken the box. The *gear brake* is used on both light and heavy wagons. It does not weaken the box and, further, it may be used when the gear without the box is used for hauling.

**Lock chains.** In some sections instead of a brake, chains are used to lock one of the rear wheels. These are attached to the wagon bed and fastened to the wheel by means of a latch. The disadvantage is that this device puts undue strain on both the wheel and the bed, and is inconvenient to lock and unlock when the wagon is heavily loaded.

**Width of wagon track.** In the past all wagons were constructed to meet local requirements. Two widths of wagon tracks gradually developed: (1) the narrow or regular measuring 4½ feet from centre to centre of tires; and (2) the wide, measuring 5 feet. The regular width was used nearly altogether in the northern states and the wide width in the western states. As already mentioned, all wagons are now constructed with a 56-inch track, which is the standard tread for automobiles.

**Painting the wagon.** In careful wagon making, all gear parts when

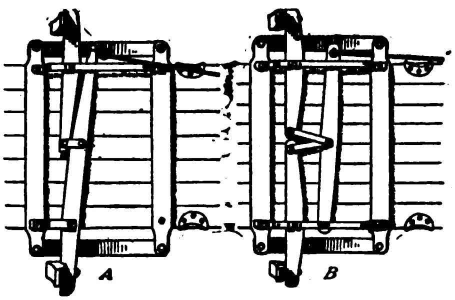


FIG. 14. Bottom views of two types of brakes: *a* joint box brake; *b* three-piece box brake

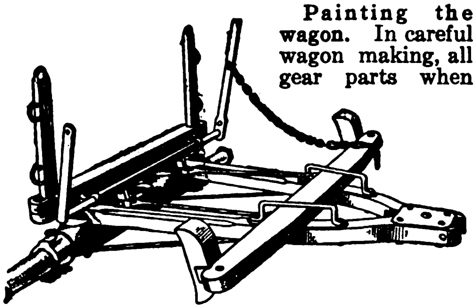


FIG. 16. Eastern gear brake

finished are soaked in linseed oil and put into a warm room for from 3 to 8 months so that the oil will penetrate into the wood before the paint is applied. One coat of paint should be applied before the ironing is done to keep the moisture from entering the wood under the irons. After ironing, at least 2 more coats of red lead should be applied and these followed by a coat of wagon varnish. Many farm implements are given a coat of paint by dipping, but this is not good practice; a wagon especially should be carefully painted and varnished all over by hand.

## The Care of a Wagon

The first point to consider in the care of a wagon is proper housing. Many wagons have, no doubt, been injured more by being exposed to the weather than by use. Properly cared for wagons have been known to last for more than 25 years.

**Lubrication.** The spindles should be greased at regular intervals. Before the grease is applied the spindle or skein should be wiped off with a rag so that all of the grit and dirt is removed before fresh grease is applied. Do not wait to grease until the wagon screeches; it is best to use less grease at a time and apply it oftener. Too much at a time is not only wasted but gathers dust and in some cases does more harm than good. Use a good grade of axle grease and not one that "gums."

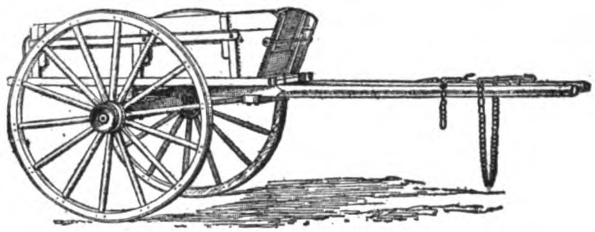


FIG. 17. Plantation or dump cart

**Care of wheels.** These should be carefully watched to see that the tires stay tight. The pounding over a stony road will eventually lengthen a tire and with the shrinking of the wood in summer it may run off the wheel. A tire should be reset by a competent blacksmith as soon as it begins to work loose. In doing this he should cut enough out of the felloe to allow it to draw up snugly on the spokes and force them firmly into the hubs. If too little is cut out the wheel becomes felloe bound and the spokes will work loose. If too much is cut out, when the tire is shrunk on the wheel will be over dished.

See that all bolts are kept tightened and that any that are lost are replaced immediately; otherwise, the wagon is weakened. It will add much to the life of a wagon if it is repainted every few years with a coat of red lead and oil.

## Types and Sizes of Wagons

**Wagon construction standardized.** The construction of wagons is now on a standardized basis as a result of the efforts of the Conservation Division of the War Industries Board and the coöperation of the wagon manufacturers. The standardized schedule went into effect January 1, 1919, with the exception of portions referring to wheel construction and the manufacture of parts for the repair of wagons still in use.

The standardized manufacture of wagons makes it possible to save material and labor through the elimination of unnecessary types and sizes. It means greater economy in cost of handling from the standpoints of both manufacturer and local distributer. A smaller

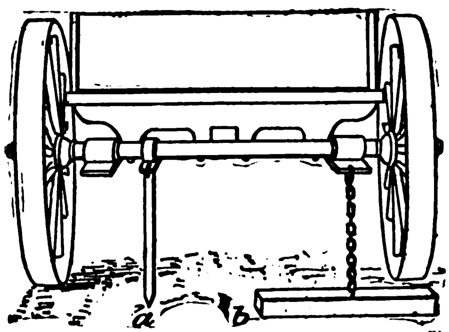



FIG. 18. Devices for holding a wagon on a steep hill

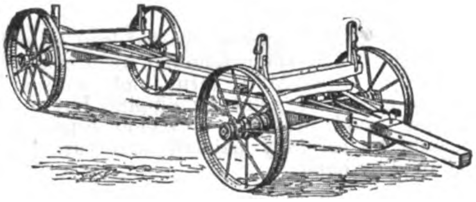


FIG. 19. Farm truck or handy wagon suitable for use with convertible body. (See Figs. 21, 22, 23.)

stock can be carried by the latter and better service given to the user. The final result is a better wagon at a saving for the farmer.

The principal features of standard built wagons are: (1) the four standard capacities of the different classes; (2) the marking of the capacity on the gear of each wagon; (3) the standard width of track of 56 inches which is the same track made by automobiles; (4) the standard width between stakes, making wagon boxes interchangeable; (5) the standard width of boxes; and (6) the standard gear for each capacity, the front gear to be made with drop slip or coach tongue type. Other minor details are also made standard.

## Special Types of Farm Wagon

**The handy wagon or farm truck.** The handy wagon is a low-wheeled, broad-tired wagon often needed on every farm. A suitable rack fits it for hauling almost any sort of farm load. Handy wagons can be secured with either metal or wooden wheels, but the latter type are, no doubt, better suited for hauling through mud as there is less tendency for the wheel to fill with mud above the tire.

The handy under-hung wagon is a standard high-wheeled wagon that has been remodeled to bring the bed nearer the ground for convenience in loading and unloading. The wagon-bed proper can be made almost any width or length desired depending on the strength of the remodeled wagon and the size of the team. The remodeling consists of removing the rear skeins and fitting them on a 4 x 6-inch axle long enough to accommodate the width of bed desired. The beams and all other parts should be made of strong materials and well ironed.

**Spring wagons** are much better adapted for all kinds of light delivery work than those without springs. They can make better speed and are much used in truck- and fruit-growing sections. These wagons may be of either the one- or the two-horse type according to the capacity desired.

**Dump carts or plantation carts** are largely used in certain parts of the South, principally on account of the easy manner in which they can be loaded, and because they can be gotten to the point of loading with much less difficulty than can a wagon. They are still used in many southern cities for drayage work and almost altogether for hauling sugar cane on many large Louisiana sugar plantations. One type of dump cart is made by taking an ordinary 2-wheel cart, shortening the tongue and fastening it to the forward axle of a wagon with a king bolt. It can be turned easier than a cart of the ordinary type, and is a convenient cart for hauling about the farm.

**Modern sleds.** A great change has been made in the sled since it was first used by our forefathers. Climatic conditions, of course, have much to do with the type in use. Throughout the North where the snow covers the ground for several months, the bed is removed from the wagon and placed on a bob sled. Such a sled with 2 knees in each bob would have a capacity of about 2 tons, depending on the materials used and its construction. After a sled is started there is very little draft so a team can pull a much greater load on one than on a wagon. To get the sled in motion a lead team is sometimes used, but a bar in the hands of a good driver is usually all that is necessary. In hilly regions some provision must be made to hold the load back when going down the slope; a chain attached to the runner and dropped beneath it is often used. To prevent a sled from sliding backward a curved spike is often bolted to the sled. In northern logging camps where sleds are much used, the heavy work calls for strong runners under a very strong frame. Northern farmers who haul out manure in winter and do not have a manure spreader will find a dump sled a great convenience. Such a sled is made by using the front bob of a double sled and raising the framework to a sufficient height to carry the box which is secured to it by means of eyebolts, staples, and pin.

## Hitches

In hitching to the ordinary farm wagon, the straight 2-horse hitch is used. In using 3 horses in some localities they are hitched abreast by means of a 3-horse evener. In other localities 1 horse is hitched to the point of the tongue as a leader by means of a single tree. The latter method is also used in hitching 4 horses. The relation of the construction of the wagon to its draft has already been mentioned. It is well to remember that the line of draft, the length of the traces, and the position of the load in the wagon also affect

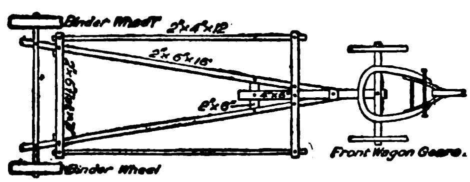



FIG. 20. Home-made fodder wagon and rack

the draft. The proper line of draft varies with the type of road surface. If this is hard and does not yield to the weight of the load, the line of draft of the trace should be parallel to the general surface of the roadway. If the wheels sink into the road surface, the line of draft should be raised. Shortening the traces will do this. However, any adjustment of the traces made to change the line of draft should not interfere with the angle they make with the hames. The traces should always be as nearly as possible at right angles to the hames so the collar will bear uniformly against the shoulder. If the point of the hitch is very low there is a tendency to carry the greater part of the load on the withers, which is objectionable.

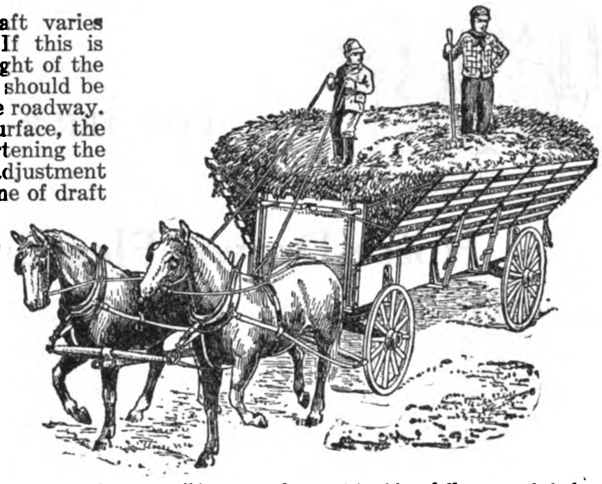


FIG. 22. A convertible wagon-bed, with sides fully extended for hauling loose fodder, etc.

**Loading.** The proper distribution of a load on a wagon is a much discussed question. Where only a part of a load is carried, it is usually placed well forward on the wagon, especially if the roads are soft. This, in effect, raises the line of draft so the team will tend to lift the load out of the mud. It makes little difference whether the load is forward or back if the road is hard and does not yield to the wheels. When the wagon is fully loaded it is better to place more weight over the rear wheels for two reasons: (1) by lightening the load forward, a certain amount of play in the front axle over rough ground is permitted; (2) the rear wheels are of larger diameter than the front wheels, and have a greater base of support and, therefore, do not cut into the roadbed as badly as the front wheels. Thus there is less draft for the larger wheels.

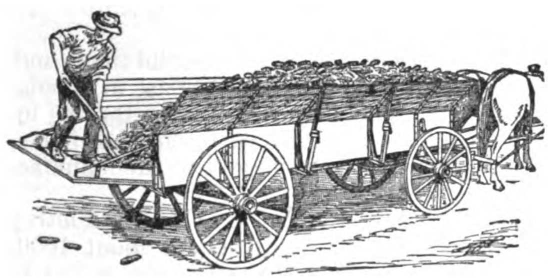


FIG. 21. A convertible wagon-bed, with end gate down

**Double trees.** To have a load uniformly divided between 2 horses where a 2-horse evener is used, it is necessary to have the 3 holes in the evener in a straight line. With an evener so constructed, it does not matter in what position the horses are, the load will be equally divided. If the centre hole is ahead or behind the line of the two end holes, the horses will not pull the same except when they are even. In one case, the horse ahead will be pulling more and in the other case less.

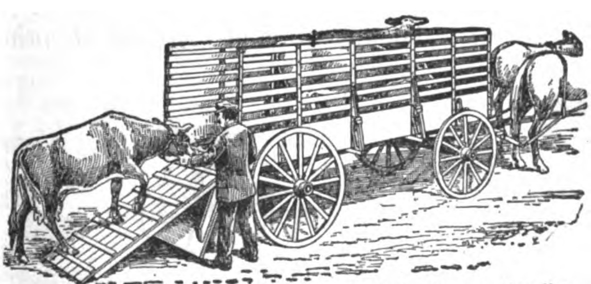


FIG. 23. A convertible wagon-bed, as used for transporting live-stock

FIG. 24. French state chariot of 13th century

CHAPTER 2

FIG. 25. Scythian house on wheels

# Horse-Drawn Pleasure Vehicles

*By* PROFESSOR E. W. LEHMANN, *University of Missouri (See Chapter 1). With the increased use of machinery in modern times, there is a growing tendency to think of the automobile as the only real pleasure vehicle. Certainly it has its place (See Chapter 4), but certainly also it is not going to entirely replace the horse as a means of obtaining pleasure and recreation any more than the tractor has entirely replaced or is going to entirely replace the horse as a source of power. But pleasure driving hereafter is going to be restricted largely to the open country; it is to be one of the rewards of those who live there. It is therefore those who live on farms who should know the most about the essentials and possibilities of pleasure vehicles.*—EDITOR.

**THE development of pleasure vehicles.** The early pleasure vehicles were very elaborate in their design and finish. Along about the sixteenth century the nobles of Europe supplied themselves with the most beautiful and extravagantly adorned coaches; often thousands of dollars were spent on a single coach. During the seventeenth, eighteenth, and nineteenth centuries the construction of all types of pleasure vehicles gradually became more simple and efficient.

The carriage industry in America has existed since early Colonial times and, up to the census of 1904, its growth about kept pace with the increase in population. However, the advent of the automobile has had a decidedly retarding influence on the industry. Many companies have been forced to close their factories, while others have turned their attention wholly or in part to the manufacture of automobiles.

There were three types of early American pleasure vehicles. One was a heavy cumbrous 2-horse outfit that had come into limited use in England about 1600; this type was not a success. The other two were lighter and better suited to American conditions at that time. One of these—an open two-wheeled outfit—was called a chair. The other, called a chaise (and later a "one-horse shay"), was simply a chair provided with a top. Few springs were used in those days. The vehicles were swung on braces of either wood or leather. Steel springs were used as early as 1670, but it was not until 1804, when Obadiah Elliott patented the elliptical spring, which is now so widely used on all types of vehicles, that they were used to any extent. The invention of this type of spring, along with the

FIG. 26. George Washington's private coach

FIG. 27. One-horse shay

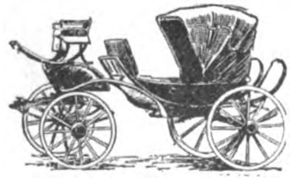


FIG. 28. President Lincoln's state coach

increased building of improved roads, brought about the real development of the carriage industry.

Two factors affect the design of pleasure vehicles: they are utility and fashion. The usefulness of the horse-drawn vehicle is given more attention now than formerly. Practically all horse-drawn pleasure vehicles used at the present time represent forms of either the common top buggy or the road wagon. The private coach of Washington and the carriage provided for LaFayette were much more elaborate than Lincoln's but not more useful. A description of President Harrison's buggy tells very clearly of its useful features. "It is for one horse and has a large roomy place under the seat big enough to take in a minnow basket, a watermelon, a basket of lunch (even the catsup bottle may reach above the handle), and a great many other things hardly worth mentioning. Back of the seat the place is all boxed up so that the boys at the camp meeting can not steal anything from behind. There is room under the seat for his shotgun and quail bag." President Harrison considered very carefully the utility of his carriages.

## Types of Pleasure Vehicles

There are many types of sporting carriages and vehicles used by the wealthy class of the cities and by men and women who show horses. Coaching, a sport indulged in, in America, only by the rich, is confined to New York and the neighboring cities. It requires a great deal of skill and judgment to handle a coach with four or more horses attached. All these show vehicles are carefully and accurately made. Mr. H. H. Salmon in the official Horse Show Blue Book makes the following statement: "In vehicles the standards are already so excellent that the provision of the first-class carriage maker may be accepted as correct." In other words, the broughams, victorias, hansoms, coaches, phaetons, and carts of all sorts are practically perfect as made by the best carriage makers.

The *brougham* or *coupé* is a closed carriage with a seat for the driver in front, ordinarily called a cab or "bus." The *victoria* is an open-hooded carriage with two seats. It is used for park driving in the cities. The *hansom* (invented in 1834 by Joseph Hansom) is a two-wheeled vehicle with the driver's seat behind and above the body. The *phaeton* is used a great deal, but the basket type is not as common as the ordinary type. The phaeton may be provided with either a folding top or a canopy. The *landau* is a large carriage for 4 passengers with a folding top. The *rockaway* resembles the *landau*, but is higher, lighter, and less costly. It is quite suitable for country use and for small towns.

Carts. There is a distinct class of 2-wheeled vehicles used for pleasure and in breaking colts and exercising horses both in the country and in the cities. An essential feature of a light-draft pleasure cart is a proper balance such that its weight is removed from the horse's back, thereby making it easier to pull. In this it differs from heavy one-horse work carts. With them weight is sometimes put on the horse's back to increase its traction. The *gig* is a common type of cart with one seat. The Irish *jaunting car* has two seats placed back to back. Road carts of various types are useful, convenient, and easy on the horse but not very comfortable. The *trotting sulky* is a type of cart representing a purely American product. It is made light of draft by being provided with ball bearings and with either solid or pneumatic rubber tires. The improvement of the modern sulky has done much to lower trotting records.

Types found on farms. The *surreys* and *carryalls* are being displaced by automobiles in many localities. There is more general use of these types of vehicles throughout the South and East than through the North and West. Surreys are usually provided with either extension or canopy tops, but a light, open surrey is also used. A surrey should be well constructed, of first class material and provided with 2 or 3 strong elliptical springs. (For easy riding the latter type is best.)

The greatest demand for horse-drawn pleasure vehicles at this time is for top *buggies* and *runabouts* or open buggies. The latter are sometimes called driving wagons. The platform spring wagon is also used in some sections. This type of carriage is pro-

FIG. 29. Surrey

FIG. 30. Rockaway

vided with 2 seats, the body is supported on a special, half- or full-platform spring. In the half-platform spring type, the rear end of the body is supported by 4 springs arranged as a platform.

There is great variety in the types and designs of runabouts or open buggies. One of the most noticeable differences is found in the styles of bodies and seats. There are 2 general classes of bodies or boxes. The *piano box* is either narrow or wide and has the same height of panel all around; the *corning body* has low panels just back of the dash board. Top buggies also have these two types of bodies. Nearly all of the cheap runabouts are provided with piano bodies, but some of the highest-priced buggies have the same type. As to variety in the seats, some types of vehicle have solid one-piece seats; others, stick seats; and still others have combinations of these.

## Essentials of Good Buggy Construction

The essentials of a good buggy for pleasure driving are: (1) lightness of construction as well as light draft; (2) neatness of design; (3) excellent and durable finish; (4) strong, well-braced construction; (5) good springs, making easy riding; (6) a reliable fifth wheel; (7) well-secured clips; (8) a strong, well-made body wide enough for comfort; (9) a neat dash and boot; and (10) a seat plenty wide and provided with good springs.

The material used in a buggy is selected and seasoned with even greater care than that put into a wagon. To secure lightness, the very best and strongest materials must be used. The hickory used in carriage construction is from the younger trees, as it is stronger and more elastic. A distinct advantage is claimed for American carriage builders over those of other countries on account of the superior wood available here, and much American wood has been exported for foreign trade. The foreign design in carriage building is much heavier than the American.

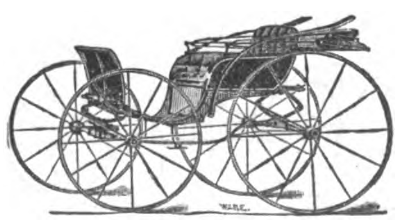


FIG. 31. Phaeton

**Wheels.** The wheels are as important a part of the pleasure vehicle as they are of the wagon. The great majority of buggy wheels are of the Sarven patent type. Some hubs are made larger in the centre which gives them greater strength where the spokes are driven which is usually the weak part of a wheel. Buggy hubs are quite often made of elm, the spokes and rims being made of straight-grain hickory. In wheel construction the tiring plays an important part. The rims are liable to be charred if the tires are put on hot from a flame. On some types of buggies the tires are heated in a tank of boiling water, which gives uniformity of heat around the entire tire, and results in the production of a better wheel than the earlier, cruder methods. A buggy tire should always be bolted to the rims, the heads of the bolts being counter sunk into the tire.

An important step in the development of pleasure vehicle construction was the introduction of rubber tires. The solid tire was first employed in the 'fifties, but did not come into general use on pleasure vehicles until the invention of the grooved tire many years later. The pneumatic tire was introduced in 1890, but, except for trotting sulkies and light runabouts, it has not found popular favor. On good macadam roads and on paved streets, rubber tires are more elastic and much less noisy than steel tires; on dirt roads they offer no special advantages. The amount of pull required for rubber-tired buggies is quite a little less than for steel tires, especially in the case of vehicles traveling at high speed. At low speeds the draft with steel and rubber tires is about the same.

FIG. 32. Solid rubber tire showing the internal wire construction.

The type of rubber tire shown at Fig. 32 illustrates the internal wire construction, by means of which the wires are protected from moisture and all danger of rusting. The channel is entirely filled with rubber preventing the entrance of dirt and moisture both of which shorten the life of a tire. Extreme care must be observed in cutting and putting on rubber tires of this sort. The wire wheel is used to a certain extent, principally on trotting sulkies and runabouts used for park driving in cities; but very little on the farm. The principal advantage of wire wheels is lightness. Such wheels are usually provided with either roller or ball bearings and pneumatic rubber tires, which together reduce the draft to the lowest possible point.

**Axles.** Buggies are usually provided with either arch or drop axles. The true arch axle is a little more expensive. Best axles are of solid steel capped with straight-grained hickory. The type of axle called the long-distance axle should be selected. It has 2 lengthwise and 2 crosswise grooves on the spindle which insure positive and thorough lubrication. It should also have a collar to protect the spindle from dirt and grit. The axle must have the proper set at all times so that the under spoke is always vertical and so the box will not wear and will hold grease. To test the proper set and gather on an axle, place the wheels on the spindle just enough to give them holding power, then pull the buggy forward and watch the wheels go in place. Proper set and gather of axle insure a light-running vehicle.

**The reach.** The bars connecting the front and rear running gear are called the reach. There are several types in use. The double bar or twin reach is used a great deal, but there are also the diverging double reach and the single reach. All buggies made by hand many years ago had a single reach. The double reach in addition to having all of the features of the other types is more flexible, and has a more positive recovery should the wheel strike an obstruction. The reach


FIG. 33. Dust-proof axle

must be of correct length, or troubles with the fifth wheel will result. If the reach becomes bent or sprung out of alignment, it will cause the upper and lower parts of the fifth wheel to fit together unevenly, thereby causing undue wear. Proper attachment of the reach also insures that the rear wheels will track with the front wheels making lighter draft. It is claimed by some that an elastic reach is better than a stiffer one, but the latter type is in more general use. A type which is highly recommended is the full length hickory reach with channel iron support. Every type of reach should be well braced and its connections are better made with clips than bolts.

**Fifth wheel.** The best fifth wheels are made of wrought iron, which is tough and strong. There should be no strain on the king bolt when in place. It should simply hold the 2 parts of the fifth wheel snugly together.

**Shafts and poles.** Shafts should be made of a good grade of straight-grained hickory. A shaft must be elastic so it can bend without breaking. Heavily ironed shafts and poles are not always an indication of quality. The

FIG. 34. Buggy

greatest cause of failure of shafts is the practice of backing or cramping the buggy, which brings a strain on the bend of the shaft causing it to splinter and break. A good type of shaft has the bend properly strengthened by trusses or braces. It is an advantage to have quick couplers connecting shaft to axle. This is especially true when it is desirable to change from shaft to a pole. With standard couplers there is no noise from loose bolts.

**Springs.** The type, strength, and elasticity of the springs determine the easy-riding qualities of a buggy; the type also affects its draft and its length of life. A stiff set of springs not only makes hard riding but also throws a strain on some other part of the buggy, eventually shortening its life. Springs must be firmly set in place on both the front and rear axles to prevent any swaying forward or backward.

**Box or body.** The piano type of body is in most general use on top and open buggies. The framing of buggy bodies is of oak or ash and the sides and panels of clear yellow poplar. Many buggy bodies are made by putting screws through the panels from the outside and filling the screw holes with wooden plugs. After such buggies have been in use for several years the plugs swell and eventually drop out. The bodies made by attaching the panels with glue and screws from the inside have a smooth surface for paint and are more satisfactory in the end. Every body should be well braced and supported, especially at the corners and the support for the seat, to prevent it spreading. A good dash brace is essential.

**The seat.** There is a variety of types of seats; that selected should be considered

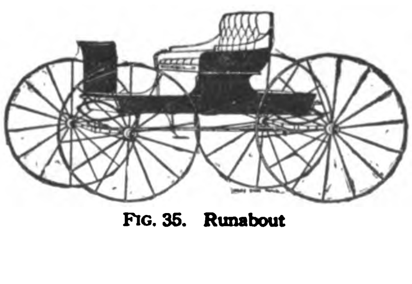


FIG. 35. Runabout

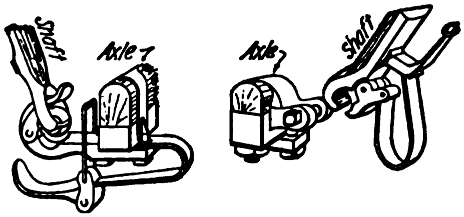



FIG. 36. Two types of quick couplers

from a standpoint of comfort and utility as well as of beauty. There are plain driving wagon seats, solid one-piece, oval-back seats, stick seats, combination stick and panel seats, the automobile type and others. Some are made of wood with carved sunken panels, others of metal lined with hardwood. The design of the seat should not be considered an important factor in selecting a buggy, but it can add much to its looks. The style of buggy varies to a certain extent with the locality. In many places the automobile pattern of seat is most common, while in other localities a buggy with this type of seat could hardly be sold. Through the South and Southeast the seat with low panel sides and low panel back is still used. Every seat should be well ironed and braced and the cushion supplied with a sagless spring. A good cushion goes far toward making a buggy comfortable and easy riding.

**Top.** The top is often one of the first parts of a buggy to become shabby and go to pieces, because of the poor material used in its construction. The top sags because the bows have not been properly braced; or because some of the folding joints break on account of flimsy construction. The props should be of steel for strength. If covered with a poor grade of material, a leaky top results. The best buggies are provided with full leather tops. A cheaper top is the "quarter leather" type, which is a top with leather sides above the curtains, while the roof is made of rubber or oil cloth. The poorest grade of tops are covered entirely with rubber or oil cloth. The covering for both the seat and top should be in keeping with the style, construction, and quality of the vehicle as a whole.

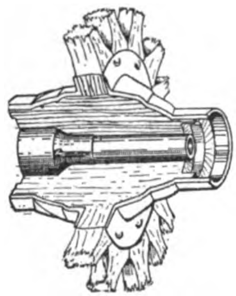


FIG. 37. Cross-section showing construction of Sarven wheel as used on light vehicles.

**Painting a buggy.** The painting of a buggy is very important and should be done only by an expert. The best results can be obtained only by using the best of materials and allowing each coat to harden sufficiently before another coat is applied. In all 12 to 18 coats should be applied. Several coats of filler should be used and between coats the surface should be well sandpapered. The finishing coat should be of the best quality varnish made of pure gum. On all of the best grade of buggies the outside irons such as steps, dash braces, and toe rails are given two coats of japan and thoroughly baked. This treatment prevents the unsightly appearance of rust on these parts shortly after the vehicle has been put into service.

## Care of Buggies and Carriages

The first requirement in the proper care of a buggy or carriage is to have it properly sheltered from the sun and rain when not in use. The common practice on many farms of keeping the carriage in a space provided in the barn next to the stables is not a good one, for the ammonia in the manure fumes is harmful to the varnish. It is best, therefore, to provide a shed apart from the barn in which to keep the carriages.

To keep a good finish on a buggy, mud should not be allowed to dry on its surface. Care must

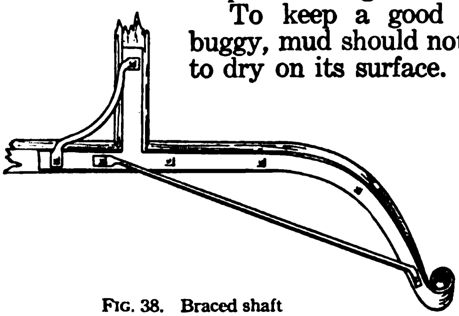


FIG. 38. Braced shaft

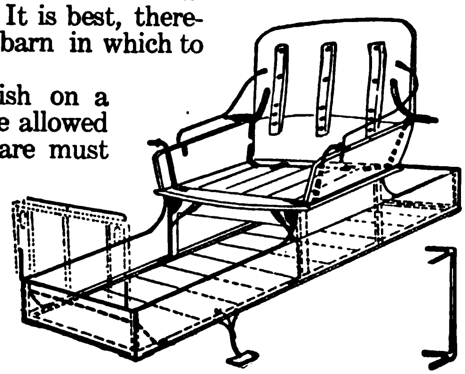


FIG. 39. Piano-box body showing metal bracing

be observed in removing mud and grit to avoid scratching the varnish. It is best to soak the mud loose and rinse it off by means of a hose or by dashing water on the surface with a bucket. The use of cold, soft water is best.

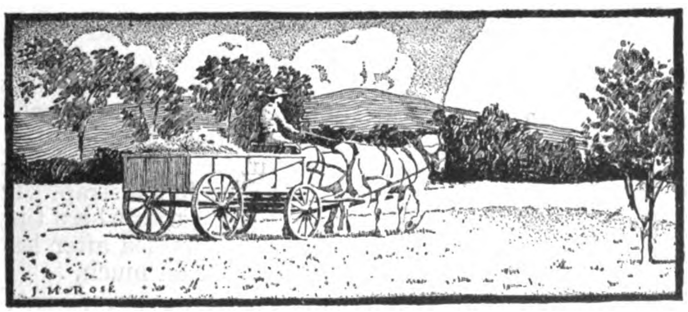
To clean a varnished surface or leather dash that looks "smoky," use a mixture of 1 part linseed or olive oil and 4 parts good vinegar. See that all dirt is removed from the surface and that it is dry, then apply the mixture liberally with a soft cloth until the surface is thoroughly wet; finally wipe clean and polish with a dry cheese cloth. The mixture must be shaken frequently while being used. Where the buggy has been used for a year or two the dash, top, and seat will become marred and discolored. To restore a new black appearance a dressing, such as is made by a number of large varnish companies, should be applied.

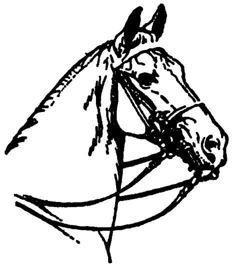
If a buggy is used a great deal, it should be revarnished each year. Before revarnishing see that all parts are tightened, then rub the surface with ground pumice stone and water until all the gloss is removed and a clean, smooth surface is secured. Have the surface thoroughly dry, then carefully apply a new, even coating of varnish.

All clips and bolts should be kept tight. The buggy that is neglected along this line becomes in a few years a veritable "rattle trap." The king bolt and attachment of the fifth wheel to the gear should be watched. Grease the fifth wheel occasionally, but do not apply too much oil as it will collect dust and cause undue wear. It is well to always clean the spindle before it is greased. A trouble sometimes experienced is that the boxing in the hub becomes loose; this occurs mostly in the cheaper grades of vehicles. Care must be observed in driving the box back into place to prevent breaking it. This can be done after proper wedging by using a piece of hardwood placed on the box and by driving with a heavy hammer.

Buggies that have been used a number of years can often be put in first-class condition at a comparatively small expense. The chief thing required is a little interest on the part of the owner. A new dash and probably a few other parts will need to be replaced. After all parts are thoroughly tightened, go over the surface with sandpaper then apply one or two coats of prepared carriage paint which can be secured at a reasonable price. The results will be most gratifying.

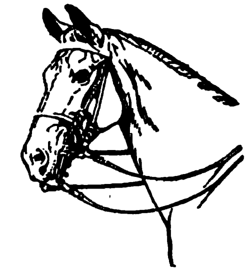
**Selecting a buggy or carriage.** In selecting a buggy or carriage many factors should be considered. Its usefulness, that is, whether or not it will meet the needs of the family, is one of the first. A carriage should be selected that has some style. It should be strong, well-built, and have ample room. It should also be easy to pull and have easy riding qualities. It should be well designed with all parts of sufficient strength. Since it is almost impossible to recognize all of the good and poor qualities of a vehicle when examining it on a dealer's floor, it is best to select a carriage that is known to be of good quality and manufactured by a company that has been in the business a great many years, and that is likely to stay in it for some time to come.





CHAPTER 3

# The Use and Care of Farm Harness



*By* J. L. EDMONDS, *Assistant Professor, Horse Husbandry, College of Agriculture of the University of Illinois, where since 1910 he has had charge of the horse breeding, the experimental horse feeding, and one of the Animal Husbandry Department farms. He graduated from the Ohio College of Agriculture and then spent 2 years in charge of horse work at the Minnesota College. He has obtained additional practical experience by working on a number of general farms, and the following large stock farms where horses are an especially important feature: Irvington Farm, Sewickley, Penn., Meadow Lawn Farm, St. Cloud, Minn., and Oak Hill Farm, Aldie, Va.*—EDITOR.

SKILL in the selection, fitting, and care of farm work harness contributes much to the economical use of horse power on the land. The horse that works comfortably will do his work on less feed than will the horse that is irritated by poorly-chosen and improperly-fitted harness; furthermore, it is less likely to form bad habits. Injuries caused by ill-fitting harness increase the possibility of a horse becoming restless when being harnessed and hitched, and may lead to the more serious vices of balking and running away. Making a good appearance with a team has a tendency to improve not only the horsemanship of the driver but also the quality of his other work. Because of the direct and indirect benefits dependent upon it, this subject of harness is worthy of careful consideration.

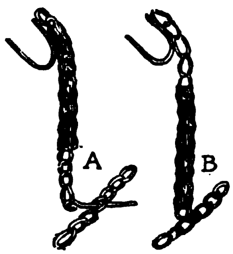



FIG. 40. Trace supporter; the sliding leather sleeve secures the hook.

**Harness making.** Harness values are quite largely determined by the quality of the material and workmanship employed in their making. The best harness leather is made from steer and heifer hides which are free from cuts, scars, and rough grain. Packer steer hides make the best grade of harness leather; country butcher hides make the cheaper grades, the reasons being that the best cattle usually go to the larger markets, and the big packers located there exercise more care and skill in taking off and handling the hides. After the hair has been removed, these hides are carefully tanned by being soaked in a series of bark baths of gradually increasing strengths. Most harness leather at the present time is tanned with combinations of materials blended in varying proportions; the principal ones employed are oak bark, hemlock bark, chestnut wood extract, and quebracho extract. There is very little harness leather which is either pure oak or pure hemlock tanned. It takes approximately 5 months properly to tan and finish harness leather, although the cheaper grades are rushed through faster.

The quality of the leather is largely determined by its feel, and can be much more readily judged in the side than after being made up into harness. Good leather has a firm and mellow feel. The strength of a strap depends upon the part of the hide from which it is taken and upon the way it is cut. Neck, belly, and leg pieces have not the strength of those cut from the back and side; cutting across the grain very materially weakens the strength of a strap. For reasons of economy, the harness maker sometimes uses weak pieces where they should not be used. Because these things are not easily determined after leather is made into harness, the honesty of the manufacturer counts for much.

**Metal parts.** Metal mountings, buckles, etc., vary greatly with respect to their design and the materials from which they are made. Commonly, they are either of brass, japanned white metal, or nickel-plated. Brass is the showiest material and is almost universally used on heavy show harness and harness of which the use has advertising value. Too much brass on a farm harness looks out of place, and its proper care requires time and labor that might be more profitably used elsewhere; brass does not rust, but tarnishes quickly. Where the teamster has but a single team to look after, as is often the case in the city, this brass may well be worth the effort needed to keep it bright because of the extra attention it attracts. On the farm harness, it is well to confine the brass to the rosettes and brow band on the bridle and, possibly, to buckle shields; the balance of the hardware may well be japanned, thus presenting a neat appearance without requiring an undue amount of time for cleaning mountings. In this connection it should be said that the use of large numbers of celluloid rings is to be discouraged as they do no good but are in the way, and also add useless weight to the harness. In general, the same considerations hold true for the farm buggy harness as for the work equipment. Genuine rubber mountings or trimmings (which are really iron parts covered with hard vulcanized rubber) are to be preferred on light harness. A harness so trimmed is not only more easily kept clean (since wiping off is all that is required) but also looks better than the one on which cheap nickel and brass mountings are used.

FIG. 41. Plain ring bit

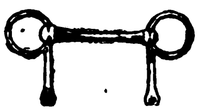


FIG. 42. Stiff mouth piece, half check Dexter snaffle.

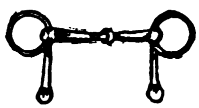


FIG. 43. Jointed mouth piece, half check Dexter snaffle.

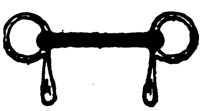


FIG. 44. Rubber mouth piece

FIG. 45. Humane bit, a very easy type, used for breaking colts.

**Hand vs. machine made harness.** The best-appearing and highest-priced harness was formerly made throughout by skilled hand labor, and some high-class custom shops still make their best harness that way. A point is finally reached, however, beyond which additional hand labor adds mainly if not solely to the appearance rather than the strength of the harness. From the standpoint of utility, the use of improved machines for stitching is entirely satisfactory. They draw stitches tighter and lock them more securely than can be done by hand. In these machines the thread is worked through hot wax which thoroughly penetrates the thread. With hand-stitching the wax is put on cold, and hence gets no farther than the surface. Hand-stitching is always necessary in the case of small parts, such as around buckles, rings, etc. Plain stitching should always be chosen. The employment of scrolls and other fancy designs detracts from the appearance of the harness and adds nothing to its strength. In the end, and all along the line, it pays to pay for good material and good workmanship. The so-called cheap harness always looks the part and is short-lived.

**Harness styles.** All harness should be neat and appropriate in design and so constructed as to be heavy enough to withstand severe strain. Some farm harness, however, are made heavier than need be; this (especially with regard to those parts which do not bear the heavy strain of the load) involves needless expense and makes them cumbersome. The particular style of harness to be chosen depends upon the use to which it is to be put. Prevailing styles, if by chance there be enough similarity to permit this statement, vary greatly in different sections of the country, sometimes with considerable reason and sometimes without much. A mountainous country requires a different style from that which might serve well in the level plains country. Again, a harness of few parts might answer the purpose when used largely for plowing, harrowing, and similar jobs, while much pulling and backing of heavily-loaded wagons would require a much more complicated outfit. Obviously, much would be gained if a style well suited to local requirements were selected for use on a given farm and all harness purchased thereafter were chosen to conform closely to the original pattern.

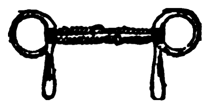


FIG. 46. Double bar, twisted wire bit, used for horses hard to hold.

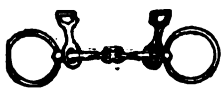


FIG. 47. Rockwell bit, a very useful bit for hard-mouthed horses.

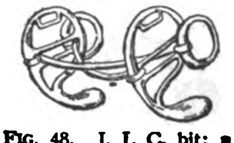


FIG. 48. J. I. C. bit; a severe bit

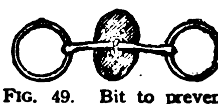


FIG. 49. Bit to prevent tongue lolling

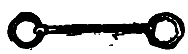


FIG. 50. Over-check bit

## Fitting Harness

An ill-fitting harness lessens both the

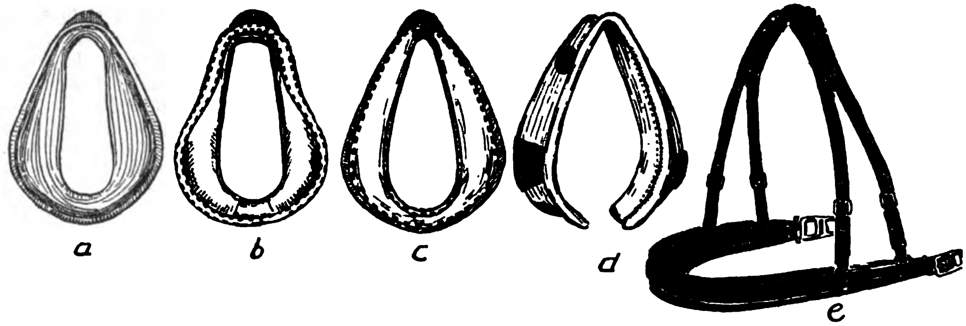



FIG. 51. Several types of collars: *a* well-made leather collar; *b* half sweeney collar; *c* narrow-topped, heavy mule collar; *d* cheap, open-throat plow collar; *e* heavy breast collar

quantity and the quality of work a horse is capable of performing; and, as has been pointed out, it may be the means by which an honest, free worker is made into an unreliable one, or even into a balker. Proper attention to fitting harness is particularly important in the case of farm horses; the working season in the spring is so short as to make it imperative that all losses of time due to poorly fitting harness be prevented.

**The bridle.** The factors which govern the fitting of the bridle are the shape of the horse's head and his disposition. The cheek-pieces should be so adjusted that the bit will not be so low in the horse's mouth as to bother him and permit him easily to get his tongue over it; on the other hand, it should not be so high as to raise the corners of the mouth and pinch the cheeks. It is generally advisable to adjust the bit rather high in a young horse's mouth so as to prevent his getting his tongue over it. The best plan is to fit the horses that are worked regularly with strong, jointed snaffle bits. Good horsemen, however, find it necessary, occasionally, to resort to something more severe, such as a double-twisted wire or a "bicycle" bit. Needless to say, pressure should be strongly applied to these bits only when the horse attempts to bolt. Mouths are easily ruined by severe bits used by unskilled drivers. The brow band must not pinch the thin skin at the base of the ears. Blinkers or blinds must be kept in place and must not fit too closely in front. The propriety of training and working some horses without blinds is not questioned. However, experience with large numbers of work horses has convinced the writer that the great majority of horses work more pleasantly and are less likely to "loaf on the job" when blinds are used. The moderate use of side check-reins or plain bearing-reins is to be recommended for work horses to prevent their getting their heads down to eat grass when stopped, and also to prevent their bridles being caught on the end of the pole.

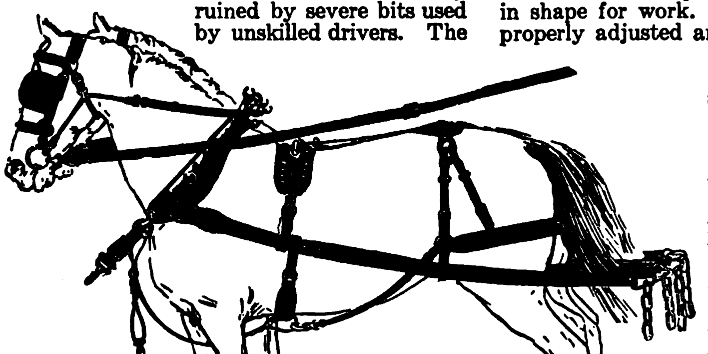


FIG. 52. A team harness with back pad and strap

**The collar.** For heavy work, well-made leather collars give the longest service. No part of the harness deserves more careful fitting than the collar. With the horse holding his head in the position in which he keeps it when at work, a collar should so fit that, when pressed firmly back with the hands, it has an even contact or bearing against all parts of the shoulders, and leaves enough space at the windpipe to insert the flat of the hand. By making use of some one of the many different styles of collars, and keeping them clean, it is possible to fit properly almost all horses and keep their necks and shoulders in shape for work. Hame straps should be properly adjusted and buckled as tightly as possible at the bottom; failure to do this has spoiled many new collars. A short trial will show what adjustment of the hame tugs is necessary to bring the pressure at the proper points. If a new leather collar is wrapped over night with wet gunny sacks before using, it will shape to the horse's neck much more quickly than if not so treated. A considerable saving in collars will

result from putting them on and taking them off over the head rather than by unbuckling them at the top, as is generally practised. Such careless handling is the reason for many collars breaking at the throat.

Sweat pads are a necessary evil since horses undergo considerable shrinkage in weight during some seasons of the year, when it becomes necessary either to use a sweat pad or to change the collar. The cutting away of portions of sweat pads sometimes relieves galled spots. A still better way of handling such trouble is to use a small cork-filled pad between the collar and the sweat pad. Wabash pads are useful, in the case of sore necks, to remove the pressure of the collar from the injured surface. The use of smooth deer-skin pads or zinc pads does much to protect the neck from becoming galled.

Breast collars are useful for light work. The shoulder strap should be so adjusted as not to allow the breast collar to interfere with the windpipe, or be so low as to hinder movement. Any extra-heavy breast collar which has been lined with sheep skin is useful in place of the regular work collar where necks or shoulders are galled. Draft stallions frequently develop so much neck and shoulder that they can be best worked in a heavy breast collar. Patent horse collars, referred to as "humane collars," are useful for field work, and as a change in case of sore shoulders or necks.

The right adjustment of some of the other parts of the harness may be worth mentioning, although it should come easily. The saddle should fit the back, and the back strap should not be too short. The crupper, when it is present, should be of good size, smooth, and well-stuffed. See that the breeching is not too low or too tight. Careful observation of the methods employed by skilful teamsters will be of much aid to the young or inexperienced farmer. In putting a horse to a vehicle, remember that the lines should be taken down and adjusted first. The careful observing of this right order in "hitching up" has prevented many accidents.

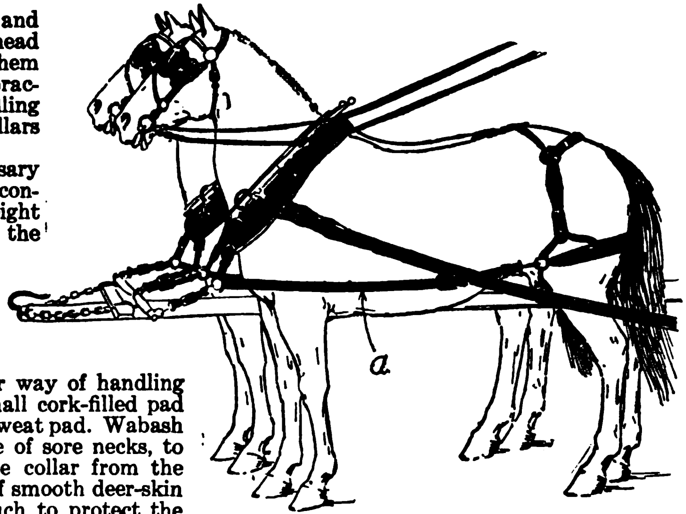



FIG. 53. An extra-heavy truck harness made with "Boston backers" (a) which are good equipment where heavy loads are to be backed or held back when going down steep grades.

## The Care of Harness

At the outset, it should be said that a harness cannot be properly cared for unless one has a suitable place in which to hang it. In damp stables it molds quickly. The presence of mold indicates that moisture is taking the place of the oil, upon which the life of the leather depends. A harness should not be stored where the ammonia from the manure can reach it. However, in regularly cleaned, airy work-horse stables, most of us prefer to have the harness hung on a hook back of each horse; or by means of a rope and pulley, to haul it up and out of the way on the post at the rear of the stall partition. In stables where a number of teamsters are employed, too much time is wasted in going to and from a central harness room; such a room should be provided, however, for the storing of supplies and extra sets of harness. In this room should be a bench and materials for making small repairs. Valuable harness should be kept in tight cases in a room where there is some artificial heat.

At least twice a year all work harness should be entirely taken apart (particular attention being paid to the straps at the buckles) and then cleaned and oiled. At these times, all needed repairs should be made. In cleaning harness, as little water as possible should be used; warm, soft water is best, but hard water may be

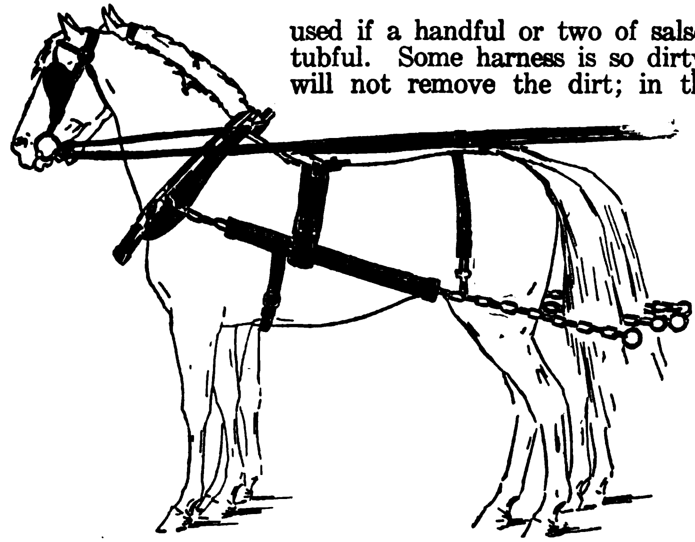


FIG. 54. A set of chain harness which is suitable for field work. They are, ordinarily, made for small horses and mules and have to be specially made when intended for use on horses approaching drafters in size.

used if a handful or two of salsoda is added to each tubful. Some harness is so dirty that sponging alone will not remove the dirt; in this case it should be soaked for 15 minutes, then scrubbed with soap and a brush, rinsed, wiped with rag or chamois, and hung on a wooden horse to dry in a warm place but away from the stove. As soon as it is dry, apply neat's-foot oil (diluted one half with a good standard harness oil, or about one fourth with kerosene) with a rag or a piece of sponge. Several applications of oil are generally needed, and it will pay to rub it well into the leather with the hands. Neat's-foot oil, when used straight, is likely to cause the work harness to become too stretchy. It may be made black by adding a tablespoonful of lamp-black per pint. When the leather shows up very red after washing, give it a coat of edge blacking before oiling. Under no circumstances is it advisable to use a drying oil, such as linseed oil. Low grade vaseline is useful for smearing over a harness which is to be stored for a considerable length of time. After the oil has soaked in, sponge the straps with a good grade of castile soap. The frequent sponging over of a harness and the use of any of the good dressings are to be recommended.

When a brilliant black finish to the harness is desired, it becomes necessary to use some one of the standard harness "compositions" which are quite similar to the best pastes used for polishing black shoes. There is, in fact, no objection to using shoe polish, except for the extra expense entailed in purchasing it in small boxes at retail stores. The paste should be evenly applied to the harness with a dauber then polished with an ordinary blacking brush, and finally with a flannel rag.

For cleaning the metal mountings, one may use most any of the liquid or paste brands of metal polish on the market. We

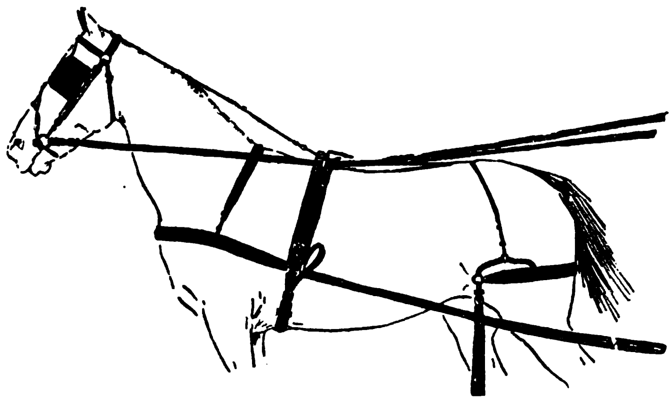


FIG. 55. A light, single-buggy harness. For use on heavy roads, it is better equipped with collar and hames instead of the breast collar as shown; a side check is more humane and on most horses just as useful as the over-check shown.

find the paste to be more economical because it does not evaporate nearly as readily as do the liquid polishes. Steel bits are cleaned by washing with soap and water, then smearing over with a cake of soap and polishing with silver sand. The soap film makes the sand stick. The fingers are of most service in rubbing the sand on the bits; a soft pine stick can be used in parts too small for the fingers. After sanding, rinse the bit, dry with a cloth, and burnish with a small steel burnisher. Forged steel bits are the strongest and also the best looking if they are kept clean. Careful drying and wiping with an oily rag after using will prevent their rusting.

It is so satisfactory to use a harness which is kept in first-class shape that one is surprised that more people do not make the effort to keep their equipment so. In the end, proper care will save both time and money. On the farm much of this work may be done at times of the year when work is slack. Minor repairs may be made at home if one has provided himself with a small repair outfit; those sold at moderate prices by the large supply houses are very satisfactory for small repairs.

Among accessories which contribute much to a horse's comfort are fly nets in summer and blankets in winter. Well-made cotton cord nets give satisfaction. Covers made of old gunny sacks are much to be preferred to none at all and should be used when economy is of first importance. Ordinarily, farm horses are healthier and better off generally, if not blanketed in the stable. A heavy blanket should, however, be used to cover the horse warmed up from work when he is stopped in the open for the taking on or putting off of a load. Heavy, waterproof, duck blankets should be worn by horses while worked in the rain in cold weather.

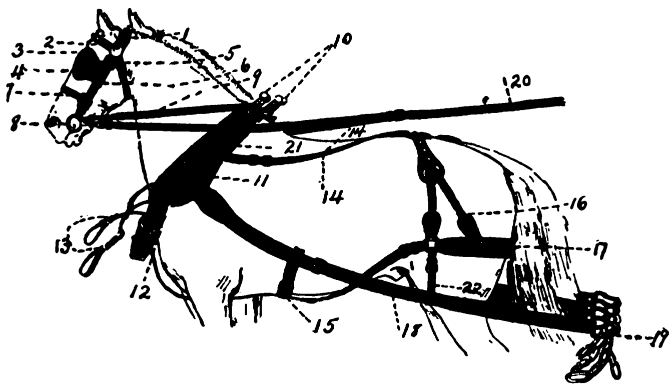



FIG. 56. Double truck harness: 1 crown-piece; 2 brow-band; 3 winker stay; 4 Concord blind; 5 throat-latch; 6 check-piece; 7 nose-band; 8 bit; 9 flat-side rein; 10 "Dandy" ball-top hames; 11 Concord bolt; 12 breast strap; 13 martingales; 14 forked back strap; 15 belly-band; 16 hip straps; 17 breeching; 18 traces; 19 heel chains; 20 lines; 21 leather collar; 22 lazy strap.

CHAPTER 4

# Motorcycles and Light Automobiles on the Farm

*By* C. V. HULL, *Charles City, Ia. Born on a farm in Ogle County, Illinois, he worked at truck farming while at high school, then went into automobile and gas engine work at Harvard, Ills., giving much time to farmers' outfits and problems. He spent two years in the Science Department of Depauw University, one year on the farm, and two more at automobile work and teaching school. For nearly eight years he was with the Hart-Parr Gas Tractor Co., doing engine and electrical work and, in addition, answering the inquiries received by its Service Department and solving the problems of gas engine and tractor owners. He has carried on a tractor engineering school, contributed to numerous farm and trade papers and in other ways developed the idea of making the practical study of gas engines and their use his lifework.*—EDITOR.

THE motorcycle. The motorcycle is speedy and inexpensive in operation. It requires but little storage room and can be used on poor roads. For these reasons it is adapted to the use of single men on the farm. On a motorcycle they can go to town easily and quickly after the chores are done; the farmer boy, too, can get away for an afternoon at a ball game or to go hunting. If a side car is used, two persons may go on a pleasure trip. In general the motorcycle may be used for pleasure just as a horse and single buggy are used, with the advantage that much greater distances may be covered in a given time.

As a business machine, the motorcycle is of great use when hurried trips to town are necessary. In sections where hired men insist on the use of a horse, a man who owns a motorcycle is entitled to more pay than others because he needs no horse. On the other hand, it is well to have a definite understanding with the motor cyclist, so that he may not spend too much time on the road.

The capacity of the motorcycle is limited to 2 or at most 3 passengers even when a side car is used; and unless the roads are good, the side car must be left at home and the 2 persons ride tandem. The motorcycle can be used but little for carrying produce, though it is a fine thing for the rural mail carrier. Few women ride motorcycles but the side car can be used by a woman quite comfortably if the roads are good. For its capacity, the motorcycle gives a great deal of pleasure and is very serviceable. Its principal limitation is lack of carrying capacity. The first cost of the motorcycle is reasonable and is the principal one, and if properly cared for, the machine entails but a small upkeep.

Before purchasing a motorcycle, the farmer should consider several factors. One is, of course, the first cost. Another is the amount of use he can make of it both for himself and for his family. If he is purchasing for the boys, he should consider whether they are capable of caring for the machine and using it wisely. A third factor is the real value of the machine for business purposes. In some cases it can be used for many trips and for long rides.

The motorcycle requires systematic care. The oil supply for the engine must be made up at regular intervals, otherwise the motor will have alternating feasts and famines of oil. The clutch and gears must be cared for according to the maker's instructions. The very best oil and grease must be used, because the motor is air-cooled. Besides, all parts of the mechanism are small and run at high speed. The magneto needs regular but slight oiling. Occasionally the contact points need cleaning and setting. All nuts and bolts must be watched and kept tight.

FIG. 57. The side car increases the usefulness of the motorcycle whether for work or pleasure

Speeding and fast riding cause many motorcycle accidents. The rider must watch the road closely because his machine is easily unbalanced. Curves must be taken with discretion, to avoid the skidding of the machine from under the rider. Mud and sand must be negotiated with care, otherwise a nasty spill may result.

When a side car is used, it must be so fastened that the front wheel is not pulled out of line.

The motorcycle requires careful handling if serious accidents are to be prevented. One should learn to ride by practising on little-used roads before he attempts to go where there is much traffic.

## Light Automobiles

At the beginning of the present century, the automobile was an experimental machine; 5 years later it was a luxury; 5 years more and it was common, although its electrical equipment was a new feature; to-day the automobile is a practical, efficient machine. Automobile riding and touring are popular pleasures. More than that, light automobiles are much used for business purposes. This is as true of farming as it is of city work.

For real pleasure the farmer can buy nothing equal to a light automobile. With it the whole family can go to town for an entertainment or any special day; and they can go comfortably and quickly with the assurance that the horses at home are resting. The farmer gains new ideas from trips in his car. The opportunity to go and see and learn is one of the greatest benefits which come to the farmer from the ownership of a light car.

The light car is a boon to the farmer's wife. Also in many cases she learns to drive. In this there is a double advantage: the wife can often get away for a half day for some neighborhood social affair, or the wife or daughter may go to town during the busy season and get supplies. This means a saving of time and, in some instances, of crops as well. The first advantage is worth more than casual consideration because it is absolutely necessary to relieve the monotony of the lives of farm women. Until the coming of the light car, the life of women on the farm was in many cases very monotonous and unpleasant. Beyond question the pleasure which comes to farm women because of the automobile is a vital factor in farm economics.

For the farming business the light car is very valuable. It saves time and horseflesh, and often makes actual money for the owner. One has but to visit

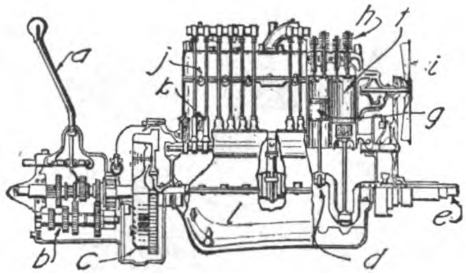



FIG. 58. Section of a typical 6-cylinder engine showing important parts: *a* transmission lever; *b* sliding gear, selective transmission; *c* flywheel, and cone clutch combined; *d*, *e* crankshaft; *f* cylinder with valves (*h*) in head; *g* piston; *i* fan of cooling system; *j* spark plug; *k* rod operated by secondary shaft operating valve.

the towns and cities of the agricultural sections to see the use of automobiles for farm purposes.

If the farmer is near a city, he can often use his light car to deliver seasonable produce. The market gardener or truck farmer can make quick deliveries with fresh goods. Much better time can be made with the automobile than with horses, and the supplies reach the market in much better condition. Besides, more time can be given to actual field work, and the horses are fresher for it.

The saving of horses when a light automobile is used is a very considerable item. Several years ago three young farmers in northern Illinois bought light cars. They were used for everything but the heavy hauling, groceries, light supplies, eggs, poultry, and light produce being carried in them. One of these men declared that they had more than saved the cost of the cars in the increased value of the horses and the greater amount of work which could be done with them. Cars are used so generally by some Iowa farmers that the heavy teams are seldom driven to town. The same statement is true of sections of the Dakotas, Minnesota, Wisconsin, Illinois, and Missouri.

The automobile is also employed by the farmer to attend auction and other sales. By its use the owner enlarges his market and increases his buying power. In this way he sees new breeds and strains and often comes in contact with men who have ideas differing from those of men in his own immediate neighborhood.

The value of the education which comes to the farmer from the labors of county agents and university extension men cannot be estimated. It is to be hoped that this work may be extended to many more states. It is giving the farmer a finer and better conception of his work. Imagine, if you can, a 25-mile trip with horses to the various farms in a county! But for the automobile, such trips would be out of the question.

**Disadvantages.** There are, however, some disadvantages which must be considered. The amount of money invested in addition to the horses used is an item of expense in interest and depreciation. One Iowa farmer who drove a light car disposed of it because he thought it less profitable than horses. He had a number of colts at all times, and used them on the road while breaking them. He contended that his horses needed the exercise and that he made more money with them than he could with a car. His conclusions are worth considering, especially where the farm can sustain a large number of horses.

The road problem is in some sections a very serious one. In the northern part of the Mississippi Valley the winter seasons are so severe that the car must stand idle, with interest and depreciation adding to the mileage costs. In justice it must be stated that some light cars can be used practically all the time that there is real need for them in the sections with bad spring roads. The fact that Iowa with notoriously bad roads has one automobile to every nine inhabitants indicates that road conditions are not so serious as they seem.

The purchaser of a light car must not attempt to race or speed with it. Such practice is unsafe even for the most skilful drivers. Light cars are very hard to control and often turn turtle or skid badly at high speed. The driver of a light car should compare his speed with that of the horses he passes rather than with the big 6-, 8-, and 12-cylinder cars which pass him. High speed means that the driver must watch more closely and move more quickly. The danger is greatly increased because the car tips and rolls more easily.

The notion that a car runs more steadily and hugs the road better at high speed is a faulty one. Naturally any object moving at high speed tends to travel in a straight line,

even if it is passing over a rough surface; but if a car strikes an obstruction or turns over at high speed the theory is quite apt to leave a twisted mass of steel, iron, and wood. If any one caution should be printed and pasted on the wind shield it is that most familiar one, "Safety First."

Overloading is also to be avoided. While the car may for a time stand the hard service, parts are strained and will sooner or later break; and in case of an accident an overload of people adds greatly to the chances of serious injury to the passengers. Besides, the depreciation is greater than it should be.

Neither is it advisable to use a light car for heavy dray or tractor work. The general opinion of automobile men seems to be that a truck must be specially designed for its work, and that heavy hauling and plowing should be done with tractors. The farmer should realize that the automobile is not a general-purpose machine.

Unnecessary use means expense. The automobile on the farm should not be used any more than is necessary. It is a waste of time and money to make two trips to town when one will do. So many people, both urban and rural folk, seem to think that it makes no difference if something is forgotten because it is so easy to go again for it. This idea may soon lead to the habit of using the car much, that the time which it saves over the use of horses is more than lost in the number of trips made. Of course if one rides for pleasure he may look at the matter differently; but for the farmer who considers that his car is a part of his business, and who uses it to add to his profit, the habit of using the automobile to excess will not help to pay the dividends. It will, on the contrary, soon prove to be a decidedly expensive practice. If the automobile is really to pay the farmer, he must plan his work with it as carefully as he does that done with horses.

Another item which must be considered is that of expense per mile. Horses, whether idle or in use, must be fed and cared for. The expense per mile or per day must be figured for 300 days or perhaps for 365 days per year. With the automobile, there is an actual cost for gasoline, oil, tire wear, and general depreciation while running. The purchaser of a car should realize this fact. While it costs practically nothing to drive the horse, every mile that a car travels means as much cost which would not arise if the automobile were idle. This cost, of course, varies with different automobiles and drivers. The best of care and capable driving cannot eliminate it. Opinions and statistics as to the actual cost per mile vary so much that accurate figures cannot be given. However, it is advisable before purchasing to find out something about the cost of running a car, interest and depreciation considered, as well as the actual mileage cost. This must be done if the car is to be used as a business unit.

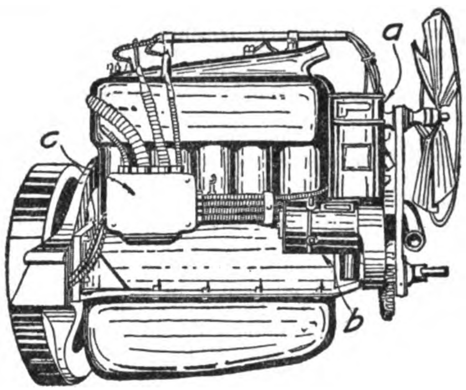



FIG. 59. Side view of a 4-cylinder engine showing the vertical generator (*a*) and the horizontal motor (*b*) of a two unit outfit, and the electrical wiring junction box (*c*).

## What Car to Buy

When the various advantages and disadvantages of a light car for the farm have been considered the farmer naturally asks, "What car shall I buy?" The neighbors can offer many suggestions, and naturally each will have his favorite car. Usually there is some basis for the various opinions. The farmer who is planning to purchase a car should consider carefully the various features of one which can be used for both business and pleasure.

Weight. In the first place the automobile should be a light one; for a light car can travel over worse roads than a heavy one and will make better time with less fuel. If the roads are heavy with mud, the large automobile is very hard to steer. If it gets off the beaten course to the side of the road, it is very hard indeed to get back. The light car is not so apt to get off the beaten track on a wet and muddy road, but if it does it can usually be brought back without great trouble. A great many commercial travelers use light automobiles, because with heavy ones they are not able to get over the roads after a rain. Also, the light car is much cheaper to buy and can be run for less money than a heavy one. The difference in gasoline, oil, and tire costs is a considerable one. From a purely business standpoint, no farmer can afford to buy a large car owing to its greater upkeep costs.

Regarded purely as an investment, the farmer's car should not be an expensive one. It should be such a car as can be replaced every 3 or 4 years without great loss. It should be a car in which produce, eggs, and light supplies can be hauled without serious injury to the seats or finish. With fair handling there is no reason why a car

should not be used for both business and pleasure. Generally speaking, the farmer cannot afford to own a car unless he does some hauling and carrying with it; hence the advisability of getting a reasonably cheap light car.

**Simplicity.** Simplicity of construction should be a prime consideration. This means that the various parts should be easily inspectable and cared for. The farmer who has not many tools will find it difficult to make even simple repairs unless the automobile is "get-at-able." The various oiling devices should be simple in operation and easy to care for. The spark coils, switches, and electrical equipment should be so located that they can be easily examined. The electrical equipment of the farm car should be as simple as possible.

Preferably the general design of the farmer's car should be simple and plain. Unnecessary tool boxes, luggage carriers, and lights should be accepted with caution. Any unusual type of body will make it harder to use the car for general work and to dispose of it when a new one is desired.

**Strength and durability.** It goes without saying that the car must be strong, even if it is light and simple. The farmer who plans to use his car for both business and pleasure must have a machine which will stand more abuse than one used for pleasure only. It should be strong enough to haul light loads or even to pull a trailer in an emergency. Also, the construction must be heavy enough to permit the machine being used on rough and bad roads without frequent breakdowns.

Durability is also a prime factor. The average farmer cannot replace his car every second or third year. He must buy a durable machine if he expects to get profitable service. This factor can be easily determined by a canvass of the machines in the neighborhood. In many cases, the old cars are not really durable but have lasted well because of a heavy expense bill for repairs. A durable car is one which stands hard service without excessive repair bills.

If the car is to be used for hauling and other business work, it must be dependable. The proper course is to judge the dependability of any automobile by the average action and life of the machine and then to buy a car of a make which is giving good service in the hands of several users. However, the reliability of an automobile depends to a surprising extent upon the ability of its caretaker. No car can be expected to be reliable unless it is properly cared for.

The farmer's automobile must be serviceable unless it is bought purely for pleasure. While it may not be advisable to use the automobile as a dray, it ought to be of use in a hundred other ways. A serviceable car is one which can be used for going out to the field, down to the pasture, or up to the wood lot. It is not truly serviceable unless a few light articles can be loaded on it and taken where needed. It would be a mistake to drive a team a mile or two to repair a fence when the few tools required could be loaded in and the fence repaired in a third of the time by the use of a car. It is a serious blunder to tie up a lot of money in a car which is too nice for practical farm work. If a car is to be a paying investment, it must be serviceable.

**Cost.** The cost of the car is one of the first items to be considered. A National Tractor demonstration was held in 1916 at Cedar Rapids, Iowa. Thousands of farmers came in cars. These cars were of various prices, but very few were of the really ex-

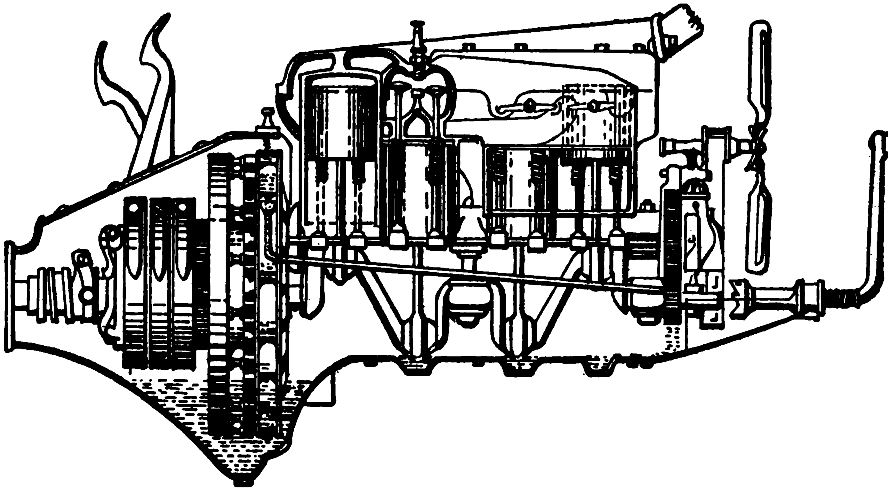


FIG. 60. Section of a popular 4-cylinder engine showing a finely designed planetary transmission using a multiple disc clutch. Compare Fig. 58.

pensive class. Even in the prosperous Mississippi Valley, there are not many farmers who drive cars listing over $2,500. The practical car for the farmer is one which costs much less.

From a practical standpoint, the automobile has no place in farm economy unless it effects a saving. That a high-priced car can be used enough for actual farm work to pay, is hardly possible, so from an economic point, the cheaper automobiles are the better for farm service. Of course the farmer who buys for pleasure and can afford to do so ought to buy a comparatively large car because it will ride easier and go faster than a lighter, cheaper one.

Fortunately several makes of light, reliable cars listed at $1,000, more or less, are now on the market. In many cases, these smaller cars have proved more durable than the larger, more expensive makes. They are strong and efficient. They have been sold long enough to give ample opportunity to judge the various features in their design and to tell whether they are suited for any particular section of the country. Most of the reasonably priced cars meet the requirements of the average farmer. They are serviceable and finished so well that they can be used for pleasure as well as for farming purposes.

Naturally the farmer who plans to purchase a car first decides how much money he can afford to invest. For the man who plans for $600 or less, the choice lies between second-hand cars or a new one without electrical starting equipment. Generally, though exceptions may be found, the second-hand car does not pay. The electrical starting device is a great convenience but not a necessity. Probably half the cars used by farmers are of a make the engine of which must be cranked by hand. In some cases, cars of this make are equipped with extra electrical parts for power starting. However, this adds to the complication and increases the weight as well as the cost of the machine.

There are a number of makes in the $750 class. These are in most cases very satisfactory machines, being fully equipped electrically for lighting and starting. Cars of this grade are neat and trim in appearance and well finished. Farmers can get excellent service from cars costing about $1,000.

Another popular class is that of cars listing at about $1,500. In most cases cars of this class have longer wheelbases and a more roomy body than those of the above-mentioned classes. They ride easier and travel faster with comparative safety. There are more refinements in the body and chassis, some of which are, however, more or less unnecessary. The expense of operation is greater, while actual service is not increased. Of course the car rides easier, the body is roomier, and the cushions are deeper. But none of these advantages adds to the efficiency of the car for farm use. However, the real question to be decided about the car of this class is whether the farmer can afford to purchase and run it.

Cars costing from $1,500 to $2,000 constitute the last class which the farmer can afford to consider, unless he buys the car solely for a pleasure vehicle with the expectation of spending considerable money for its operation. An automobile of this class is quite heavy. Muddy roads and rainy weather will often prevent its use. Tires, too, become a heavy item of expense both for upkeep and renewals. The gasoline consumption may run to 3 times that of the light car in the first class. Because road conditions may prevent the use of large cars, they are not so serviceable and dependable as the smaller ones. Cars of the $1,500 class are rather heavy, though it must be conceded that they are comfortable and "classy."

The big heavy car is out of the question for the farmer. It costs too much, is hard to handle on poor roads, and requires too much attention. The farmer must consider all these things before he buys his car. First cost, upkeep, depreciation, and interest are important. If the farmer considers them he will logically purchase a light, reasonably priced car which he can use rain or shine most of the year.

## Points of a Good Car

**The engine.** When the decision to purchase has been made there come problems of design and construction. One salesman recommends the 4-cylinder motor. He states that the best-known machine in the world has a 4-cylinder motor, and that many of the old, experienced companies still continue to build 4- and 8-cylinder motors. He talks glibly of the simplicity and compactness of the 4, and assures the customer that it is bound to be the final type in standardized cars. All of this is more or less true, yet there are other types to consider. The 6-cylinder motor is very popular. It is theoretically a well-balanced motor and may run at high speeds without excessive vibration. The

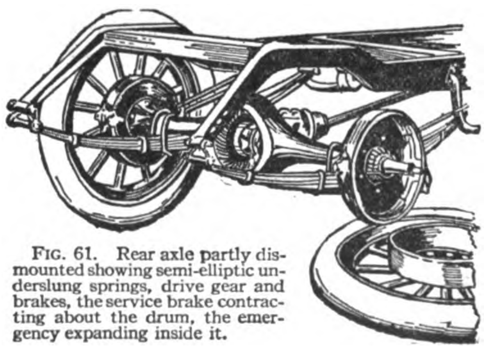


FIG. 61. Rear axle partly dismounted showing semi-elliptic underslung springs, drive gear and brakes, the service brake contracting about the drum, the emergency expanding inside it.

torque or turning force is very steady. The long-stroke, 6-cylinder engine is a good puller at low speeds because of the greater number of strokes per revolution. The cylinders are smaller than they are in a 4-cylinder of the same power and speed. The number of parts and their complication are not increased enough to be objectionable.

On the other hand, the 6-cylinder engine must be quite long. This may mean a longer wheelbase and added expense or a more compact seating arrangement. It also means complication in the ignition devices. There are more small parts to get out of order and cause misfiring.

The 8-cylinder engine has good balance, runs smoothly, and takes only the space of the 4. The torque is excellent and the engine is very flexible. It is, however, a complicated motor the cylinders of which must set at an angle. This makes an extremely efficient lubricating arrangement an absolute necessity. In the very nature of the case, the engine cannot be as simple and accessible as a 4- or 6-cylinder. The 12-cylinder engine is not a farmer's type.

After all, the important feature of the engine is its efficiency. So long as the engine is

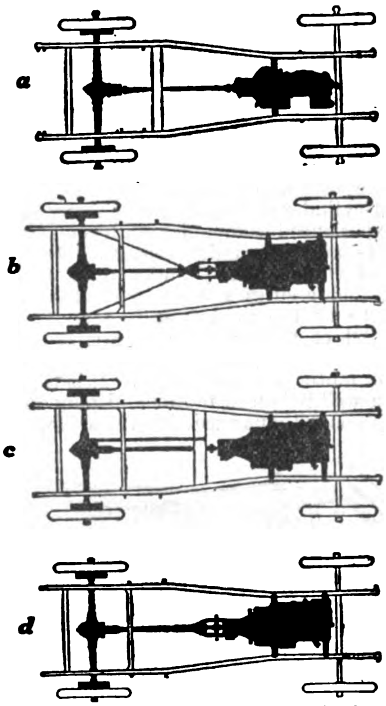



FIG. 62. Types of drive: *a* Hotchkiss simple and light, giving drive and torque through rear springs; *b* drive by torque tube and radius rods strengthened by yoke; *c* drive by torque beam fastened to rear axle and a frame member; *d* typical torque tube and yoke drive. (Oakland Motor Co.)

dependable and durable the number of cylinders does not matter so much.

**Transmission.** Two forms of transmission are generally found on farmer-owned cars: the planetary type and the selective gear type. The friction type has never become popular among farmers and the magnetic type is too expensive for most of them. This is true also of magnetic control of gear sets. In one popular car in which it is used entirely, planetary transmission is quite satisfactory. It is rather noisy, and the bands require occasional adjustment.

The selective type has the advantage of giving 3 speeds ahead instead of 2. In high-priced cars, 4 speeds are sometimes arranged for. The selective type gives a positive drive at all times and is comparatively quiet if kept in good condition. The purchaser should, however, make a careful examination of the transmission in order to be assured that it is well made and easily cared for.

**Control.** The majority of light automobiles are steered from the left. Since the general custom is to pass on the right, left steering control makes it easier to gauge the distance between automobiles and rigs, though it is easier to see the roadside from a right controlled car. But with a left-hand steering wheel, the gear-shifting levers and emergency brake may be placed in the centre. The clutch is then operated by the left foot, and brake and foot throttle by the right foot. Also, the various switches and adjusting screws are more easily reached with the right hand. This arrangement is almost standard for medium-priced cars.

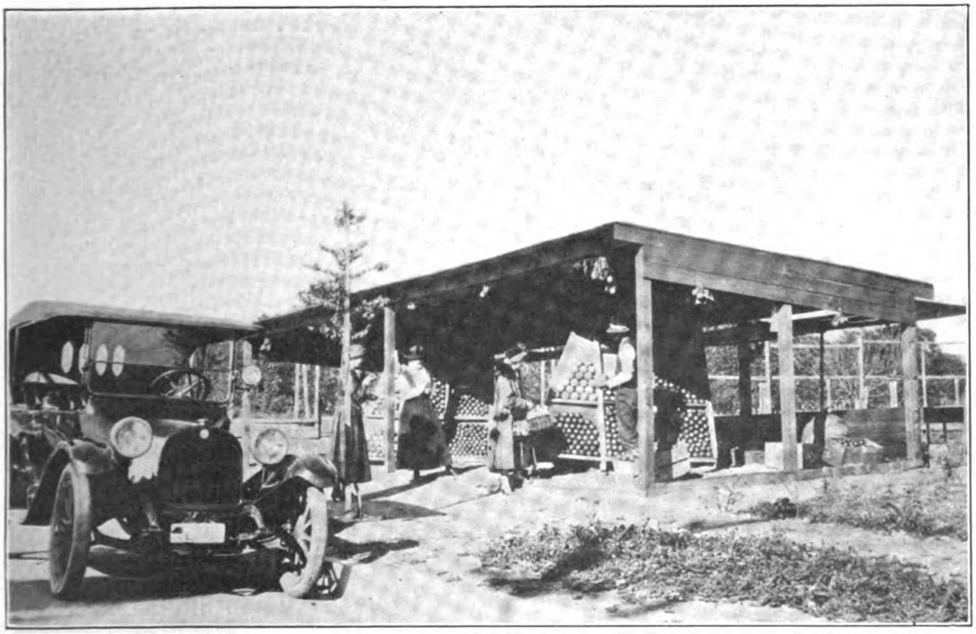
The well-known cheaper car with planetary transmission has a left-hand steering wheel. In this one, however, the hand-brake lever is on the left hand, while the clutch is operated by the left foot, the service brake by the right foot, and the reverse by either. The purchaser of a really good car of reasonable price must take this arrangement or get a higher-priced car.

The foot throttle should be convenient for the average man and easy in action. The preferable kind is one which moves quite a bit from light to full feed of fuel. If the car has no foot throttle, it should be equipped with one, to make it easier to handle in tight places.

**Gasoline feed systems.** Gravity feed from fuel tank to carburetor is the simple way; but in some types the tank is so far from the carburetor that fuel does not flow when the machine is on a heavy grade. If the fuel tank is under the dash, and hence just above the motor, gravity feed will be good, but the fire risk will be increased.

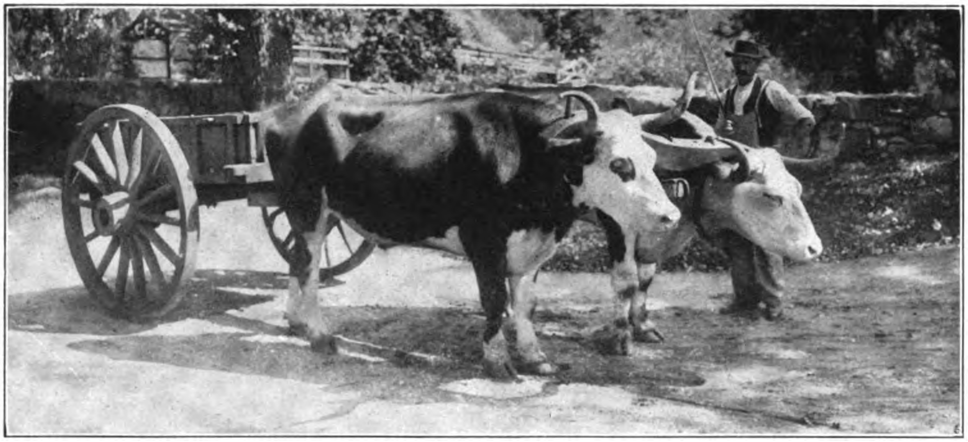
The vacuum feed system is a device for conveying fuel to the carburetor. The arrangement is such that the vacuum in the intake manifold is used to suck fuel from the supply tank to a cup which feeds the carburetor. The vacuum feed system is really an

Whether for business trips or pleasure drives, the horse and carryall or democrat remain the preferred means of transportation for many farmers

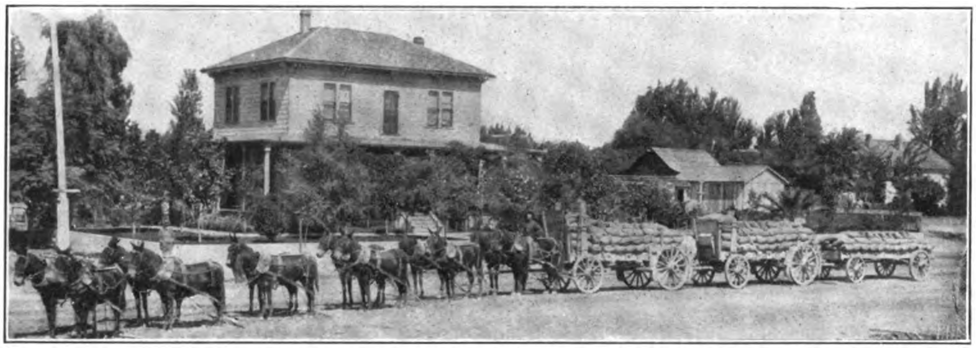


However, the automobile, having been brought within reach of the average farmer, in both cost and simplicity of operation, is being accepted by him more and more readily

THE PLEASURE VEHICLE IS AN IMPORTANT FACTOR IN FARM LIFE. IT KEEPS COUNTRY FOLK IN TOUCH WITH EACH OTHER AND WITH THE OUTSIDE AS NOTHING ELSE CAN



The ox team is an almost extinct relic of the plodding but persistent progress of pioneer days



A twelve-mule-team load of grain in California

The sort of outfit that can do, at one trip, the hauling for an entire community

THE LIMITS OF WAGON TRANSPORTATION EFFICIENCY ARE DETERMINED ONLY BY THE EXTENT OF THE FORCES THAT A MAN CAN CONTROL. EACH OF THESE IS A ONE-MAN-DRIVEN LOAD

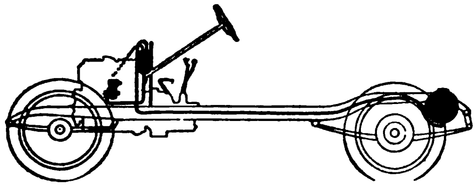


FIG. 63. Typical vacuum feed system. Fuel tank at rear and vacuum tank in front higher than carburetor. (Oakland Motor Co.)

intermittent vacuum pump whose valves are operated by the gasoline it pumps. This system permits the location of the fuel tank low down at the rear of the car. While it adds to the complication of the car it is dependable. It largely removes the danger of a destructive fire, and makes filling a simple job without much risk should gasoline be spilled.

**Wheelbase.** The wheelbase varies considerably in different makes. The light, comparatively cheap car has of necessity a short wheelbase, in some makes not much more than 100 inches. In medium types, the wheelbase is 120 inches more or less, while in the large, heavy cars it is as much as 144. The longer the wheelbase the easier the car rides, other conditions being equal. For general-purpose farm work, where an automobile must be driven over all sorts of roads and in tight places, one with a very long wheelbase requires too much space for turning. The farmer should get a car with a medium wheelbase. He may put shock absorbers on the short car and get a serviceable, comfortable machine.

**Seating.** The seating arrangement is a matter of choice. Probably a 2-seated touring car is best. It gives the most room and is a standardized construction. The back seat space can be used for carrying articles of considerable size and weight. Then, if the whole family wish to go for a pleasure trip, there is room enough. Beyond question the 5- or 7-passenger touring car is the one for farmers.

**Electrical Equipment.** If complete electrical equipment is desired, there are a number of reasonably priced cars which have it. In one group one motor generator is used. The arrangement of switches and gears is such that the same electrical unit is used to start the engine and to charge the storage batteries. This arrangement demands 2 driving devices for the unit and must be back-geared to the engine to get enough purchase to start it. But when used as a generator of current instead of a starting motor, it must run at high speed. Many ingenious devices are employed to get this double use of the unit. In a second group or type of cars, both motor and dynamo are used. In this case the motor is idle and not coupled to the engine except for starting. The generator is permanently coupled up or chain-driven at all times. Both single- and double-unit systems give excellent results in service. The best plan for the man who does not understand electrical equipment is to judge it by the performance of cars which he can watch. No matter what car is bought, the electrical starter should be heavy enough to run the engine in cold weather. The storage battery should be one of a standard make. The majority of cars are equipped with 6-volt batteries, though 12-volt batteries are also used. There is less chance of arcing (burning out) with the former, but the latter is lighter for the same amount of work.

**Tires.** For convenience, demountable rims or quickly detachable tires are to be preferred to clincher types. However, in most cases, the lower-priced cars have but one style of tire equipment.

**Springs.** The cantilever-spring suspension is popular. The manufacturers who use it claim that the springs work in such a way that the wheels tend to roll rather than bounce over bumps. Some of the most comfortable cars have elliptical springs in various combinations and forms. One can best decide about springs by actual trips in cars with various types of suspension.

**Steering gear.** The irreversible steering gear is best. With this the front wheels can easily be turned by the steering wheel, although the steering wheel cannot be turned by the front wheels. This feature gives safety; for even if the wheels strike a rut, or the grip on steering wheel loosens they will not turn aside.

**Cooling systems.** Thermo-syphon cooling, in which the water moves through the system naturally, is good. As the water becomes heated, it rises to the top of the radiator, where it cools, settles to the bottom again, and passes to the cylinders. With this plan the rapidity of circulation depends upon the work the engine is doing.

With pump circulation the water is forced through the cooling system by a pump which is connected to the engine. While there is another part to care for, the water is positively circulated. The cooling plan and the type of radiator are not so important as certain cooling. The prospective purchaser should assure himself that the cooling system will maintain the proper temperature without evaporating too much water.

**Lubrication.** In lubrication the important thing is efficiency. The motor should be well lubricated at any reasonable speed without waste or carbonization. It is a good thing to have an oil indicator on the dash, so that one can easily tell whether oil is being circulated and fed properly. Both splash and force-feed systems are successfully used, as well as a combination of the two.

**Clutch.** Both cone and multiple-disc clutches are used on standard cars. The superiority of either depends upon how well it

is made. Both give excellent service if properly cared for. The method of adjusting the clutch should be carefully studied. However, the kind of clutch is not so important as sure and easy action.

**Rear axles.** Rear axles are described as dead, semifloating, three quarter floating, and floating. In the dead axle the rear wheels are driven by gears or by chain sprockets which are mounted on a cross shaft which carries also a differential gear. This construction is much used on trucks and small chain-driven automobiles. In the semifloating type, the wheel bearings are inside the rear-axle housing, the shafts carrying part of the load. In the floating type, the rear-axle shaft bearings are outside the axle housing; the shafts may be removed by taking off the hub caps. The three-quarter floating construction is quite similar, except that the shafts are securely fastened to the wheels. About half of the well-known makes have floating axles. Because one make of light car is sold in so large numbers, it is quite probable that more than half of all automobiles in use have the semi-floating rear-axle construction. The real question regarding rear-axle construction is, are the bearings strictly high-grade and put in a well-designed axle structure?

**Brakes.** These are decidedly important. In some models, both expanding and contracting brakes are used. Generally the service brake (that used for ordinary running), is of the contracting type. The emergency brake is quite apt to be of the expanding type. In one planetary type of transmission, the service brake is part of the planetary system. Pressure on the brake lever clamps the brake band about a drum which is connected to the longitudinal drive shaft. The emergency brakes of this automobile are of the expanding type. These types are all efficient if kept in good condition. However, the prospective purchaser should insist upon a trial of the brakes to make sure that they are strong enough to be dependable.

## How to Drive an Automobile

One must have considerable experience to drive successfully. The new driver should write across the windshield "Safety First!" The first driving should be done away from traffic. A good plan is to block up the rear wheels, and practise starting, gear changing, etc., until one is thoroughly familiar with the operations. In any case it is advisable to practise driving, stopping, starting, and reversing until able to do them almost without thinking. Above all things, the new driver should go slowly. After one has driven a bit he will be tempted to drive at high speed. Yielding to this desire causes many accidents.

**Change gears quickly.** When changing gears, move the levers with a quick, strong motion. Do not hesitate an instant. Practise shifting until the gears can be engaged with a quick snap instead of a rubbing and burring. Always push the clutch pedal far enough to release the engine. In making a change of speeds, move the clutch and gear shift together. A good driver does this so quickly that the engine has no time to speed up. The clutch should be engaged easily. Slamming in the clutch is bad practice and strains the transmission. If the planetary transmission is

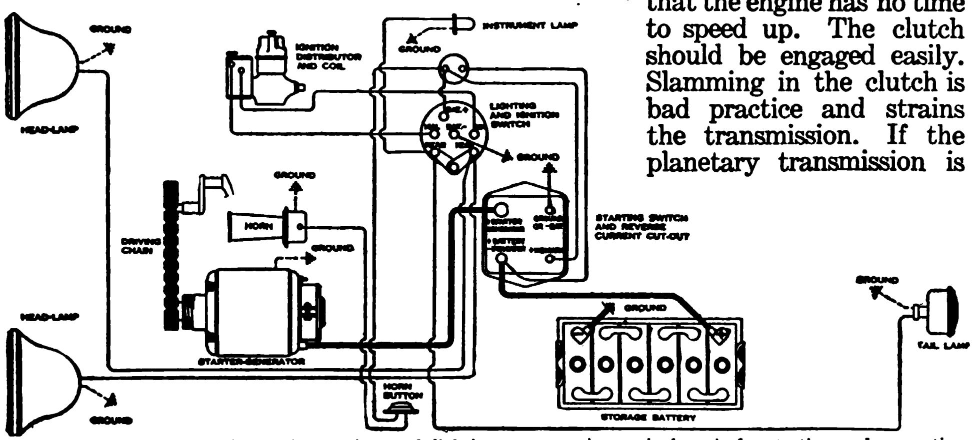



FIG. 64. Wiring plan of electric starting and lighting system using a single unit for starting and generating. (North East Electric Co.)

used, the pedals must be learned so that they can be operated without confusion. In any case racing the engine or allowing it to run at excessive speed, is a mechanical blunder, especially if the operator lets the clutch engage quickly.

**Care on the road.** On the road the smoothest track should always be chosen. Experienced drivers often find the best track at one side of the main traveled track. If possible they avoid ruts or else travel slowly while in them. Naturally curves, hidden turns, and down grades will be taken cautiously, with the machine under control. Railway crossings, culverts, and viaducts are always dangerous, and the negotiation of them should never be attempted without looking carefully for possible danger.

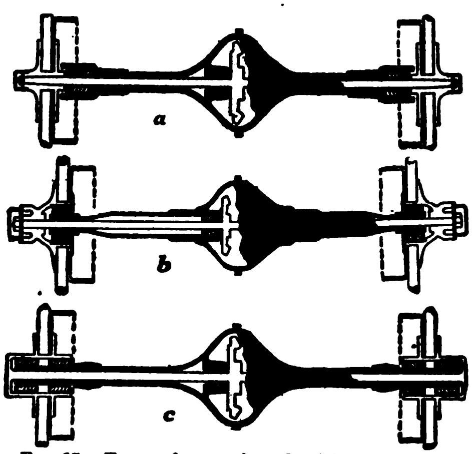



FIG. 65. Types of rear axle: *a* Semi-floating, bearings at outer ends rest directly upon axle shafts, inside axle housing; *b*, three-quarter-floating, bearings on wheels roll on axle housing; *c* full-floating, two sets of bearings in each wheel supported on axle housing. Bearings shown by cross lines. (Oakland Motor Co.).

One more suggestion for the sake of comfort: drive so that the people in the back seat are not bounced about. One is not really a good driver until he can handle an automobile so that the back seat is fairly comfortable.

## How to Care for the Car

**Engine.** Three things about the engine are important: lubrication, cooling, and adjusting. If the proper supply of oil is kept in the oil chamber, heating of bearings will seldom occur. An ample supply of water should be maintained in the cooling system at all times. Any unusual knocking or pounding should be located and the cause removed at once. If these 3 items are attended to, there will be little wear of, or damage to, the engine.

**Bearings.** The various bearings should be adjusted and oiled as the manufacturer directs. A bearing must be snug but not tight. If too loose, a plain bearing pounds; if too tight, it heats. Here again one must go carefully. Generally the inexperienced man will find that it pays best to have an expert adjust a loose crank pin or crank-shaft bearing.

**Electrical equipment.** Unless one is an electrician, it is well to let the electrical equipment alone unless dead sure that the proper adjustment is being made. Of course spark plugs must be cleaned and set, contact points must be smoothed off, and distilled water supplied to the storage battery. The average owner will make money and save time if he has a competent man to care for the magneto, battery, and accessories. This applies as well to the other accessories such as the vacuum feed system. Don't tinker!

Generally the transmission system requires little care except thorough lubrication. Looseness of parts or difficulty in gear shifting may mean trouble if the cause is not removed. The engine clutch should be just tight enough to prevent slipping and no tighter.

The steering knuckles must be kept in proper alignment to prevent excessive tire wear and hard steering. Brakes should be adjusted with care. If too loose, they will not set tight enough to hold; if too tight, the linings will wear rapidly.

Lubricating material should be placed between the leaves of the springs. This will prevent squeaking, and make the springs work more easily. On rough roads or with heavy loads, the strains on the springs are enormous. In such cases it is much better to shift to low or intermediate gear and drive slowly, than to chance breaking a spring by going on high.

**Tires.** While tires do not ride as easily when properly inflated, they wear longer and the automobile travels with less power. If the machine is to be idle for some time, it is a good plan to take the weight off the tires and reduce the pressure in them. The new driver should remember that both casing and inner tube will be ruined if driven when flat from a puncture or blow out. Ruts and fast driving over pavements are hard on tires, especially if they are a bit soft.

**Body.** The body requires care if it is to retain its finish. Mud must be washed off before it hardens and sets. Really it should be soaked loose, rather than rubbed off. A sponge is a great aid to the hose for this work. After washing, the body should be dried carefully and then polished with a chamois skin. Some one of the high-grade body polishes will add to the appearance

FIG. 66. The larger the farm, the more useful the automobile in keeping the owner in touch with its various activities.

and protect the finish as well. If the body is varnished over, use a high-grade varnish; for an inferior one will not stand the dirt, oil, and water.

**Starting troubles.** If the engine does not start, the cause may be one of the following: (1) No spark or dirty spark plugs; (2) throttle closed too much or too little; (3) lack of fuel (vacuum feed cup and carburetor cup empty, or water and dirt in pipes, etc.); (4) improper adjustment of carburetor; (5) engine and fuel too cold; (6) poor compression.

Spark trouble may be due to one of the following causes: (1) plugs full of carbon or warped; (2) dirty contact points on (a) high-tension magneto; (b) spark coils; (c) timer; (3) dirt on parts of high-tension distributor; (4) broken wire or poor dirty connection; (5) exhausted storage battery or run-down dry cells; (6) timing mechanism has slipped.

If the throttle is too tightly closed, the mixture may be too rich and flood the cylinders. If opened too wide the air velocity may not be sufficient to draw fuel. A few trials will determine the best point for setting the throttle to start.

Lack of fuel is a frequent but scarcely excusable cause of trouble. If the tank runs dry on a car equipped with vacuum feed, the engine must be turned over several times or the carburetor bowl filled. The various pockets and traps should be drained occasionally to remove water and dirt from the fuel lines.

Improper adjustment of the carburetor may cause starting trouble. If an inexperienced owner tries to adjust the carburetor he should go slowly and be sure that each move helps. By all means read the manufacturer's suggestions before trying to adjust the carburetor of a balky engine.

In cold weather an engine may start hard or even refuse to start. This is because the engine and fuel are so cold that the fuel will not vaporize readily. The remedy is to warm the engine or use something for starting which vaporizes more readily than common gasoline. High-test gasoline, warm water in the cooling system, or a warm garage will help greatly. A warm garage is perhaps the best way to end this trouble.

When the engine has been used for some time, the valves and rings on the piston may become defective so that they do not hold compression well. Poor compression adds to starting trouble.

**Overheating.** The engine may heat from one of the following causes: (1) improper cooling; (2) poor lubrication; (3) retarded ignition; (4) poor fuel mixture; (5) carbon.

If the engine overheats be sure that there is plenty of water in the cooling system. Feel the radiator and various parts to make sure that the circulation is good. Note that the pump, if one is used, is running properly and that the rubber hose connections are not flattened or cramped.

If a splash oiling system is used, be sure that there is enough oil. If a pump is used, be sure that it is running and that the pump valves are seating. In case of doubt drain out the oil and put in a fresh supply.

Late ignition will cause heating, especially when an engine has been run considerably and the compression is poor. It is best to run with the spark advanced as much as possible without pounding or clicking in the cylinder.

A poor mixture of fuel and air may cause heating. If an engine continues to heat and pound after other causes have been investigated, it is probably due to a too rich mixture from a carburetor with the auxiliary air valve set too tight.

Carbon in the cylinders may cause pounding and heating. The remedy is to remove it either by scraping or the use of the acetylene flame. A change of oil may be helpful, too.

**Other troubles.** If the automobile steers hard, the front wheels should be lined up. It is best to follow the manufacturer's instructions in this case.

Jerking and jumping when running at slow speed may indicate slipping of the clutch or misfiring. Tighten the clutch in the first case, and clean the spark plugs in the second. If the clutch is too tight it may be hard to shift the gears because the clutch will keep the shafts turning. The remedy is to loosen the clutch a bit. A tight clutch which slips badly must have new facings or new discs.

Grinding or racket in the transmission case indicates worn bearings, worn gears, or slipped parts. A good mechanic should be able to put the gear set in order. A decided pound in the gear set may indicate either the presence of some foreign matter between the gear teeth or a loose bearing. This pound should be distinguished from the hammering of loose engine bearings. Both sounds differ from the peculiar ringing sound of preignition or early firing of the cylinders. The man who plans to do his own repair work must learn to pick out the various knocks and to tell them from preignition pounds.

A noisy differential may be due to worn teeth or to poor adjustment. The remedy, if a proper adjustment does not help, is to buy new parts.

Brakes should be used with judgment.

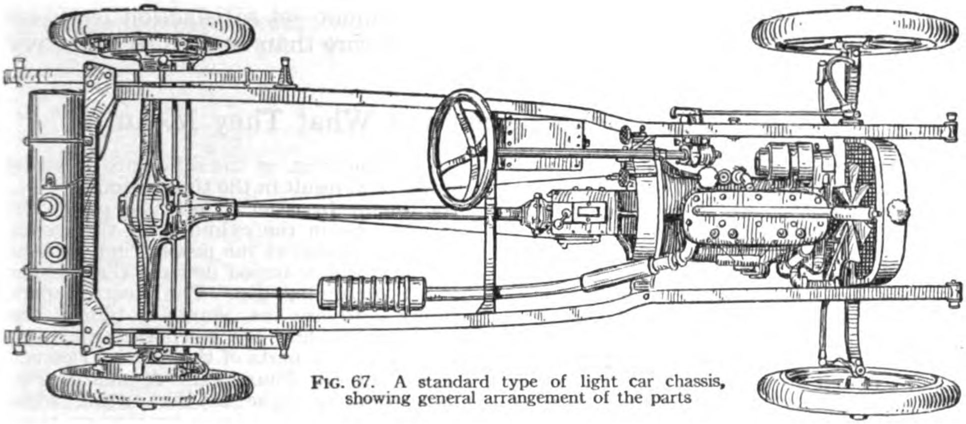


FIG. 67. A standard type of light car chassis, showing general arrangement of the parts

They ought to be set gradually except in emergencies. Never set the brakes hard on a wet pavement, for the car is almost certain to skid sideways. It is better to reduce the speed of the car gradually by shutting off the engine. The special or emergency brake should be set if the car is left where there is any chance for it to roll. The service brake is the proper one to use for ordinary running.

If the engine stops while on the road, look at the fuel tank and the carburetor. Then test the ignition, if necessary. If the motor heats, fill the radiator, look at the oil supply, and make sure that cooling water and lubricating oil are circulating. Always carry a piece of wire, well insulated, with which to splice out any broken cables. Be sure, too, to have tire repairs and replacements.

In case the electric starter fails or the hand crank is lost, jack up one rear wheel, throw in the high gear, and crank the engine with the rear wheel. Be careful in doing this.

If gears are stripped or keys sheared off it is best to get a first-class repair man at once. When the trouble comes from the electrical equipment, call a man who knows how to repair it. This should be done also in case of serious breakage or heated bearings. In general, it pays the owner to call the repair man for any job which he does not understand. It is, however, true that many repair men are not competent. For this reason one must pick his garage with care and then insist on first-class service or no pay. It not infrequently happens that the best repair man is one who is in a small shop alone and does not depend much on hired help.

**How to get the most from an automobile.** Insurance should be carried, for gasoline is always liable to burn. It is dangerous when handled carelessly. As a further precaution, a first-class fire extinguisher of the type in which the liquid is pumped should be carried. To reduce the chance of using either insurance or extinguisher, one must be careful in filling the tank and be dead sure there are no leaks.

The autoist should give his car constant attention. Careful and systematic lubrication, regular filling of the radiator, adjustment when needed, and decent driving, are the chief requirements for success with an automobile. The average man can take care of these requirements without difficulty. In case of doubt he has only to consult his instruction book or to refer the trouble to a man in whom he has confidence. The farmer autoist should remember that he is driving a perfected mechanical creation. He can then understand the importance of removing every needless noise or harmful pound if he expects to get the worth of his money.

If the driver is a "Safety First" man and gives reasonable attention to his car, it will prove a profitable and pleasurable investment; but the man who buys a car and runs it without a regular schedule for its care, and regardless of its mechanical condition, is sure to be disappointed. Assuredly a man need not be a mechanical genius to become a successful driver. It is equally certain that he must be careful

and alert to get the best results. The farmer cannot get satisfaction from his automobile unless he is willing to give to it better care than he does to his heavy farm machinery.

## Common Automobile Terms and What They Mean

**Accelerator.** A small foot-controlled pedal intended to supplement the hand throttle lever for increasing engine speed by increasing the gas supply to the engine.

**Back-firing.** (1) A popping noise in the carburetor due to mixture containing too much air; or (2) an explosion in the muffler of an unburnt charge of vapor that has been discharged from a "skipping" cylinder.

**Cantilever Spring.** A form of spring that is similar in form to the side spring ordinarily used on a buggy, except that, instead of carrying the load at the centre and being shackled to each axle at the ends, it is attached to the frame at the centre, and shackled to the frame at the front end and to the car axle at the rear. The centre support is a swiveling form to permit of spring deflection under load. This form is nearly always used for rear suspension.

**Carburetor.** A simple device attached to the gasoline engine for the purpose of producing an explosive gas for the engine by vaporizing a liquid fuel, such as gasoline, and mixing the resulting vapor with air in proportions necessary to secure extremely rapid combustion in the cylinders.

**Clutch.** A releasable driving connection interposed between the engine and the driving gearing in all gasoline automobiles and employed to disconnect the engine from the power-transmission system when it is desired to stop the vehicle without stopping the engine, and, after the car has been stopped to secure a gradual start by engaging the clutch gradually when it is desired to resume motion.

**Chassis.** Name given to all parts of the automobile mechanism when the body is removed. It includes the frame, wheels, axles, springs, power plant, change-speed gearing, power-transmission system, and control elements.

**Cylinders Cast en Bloc.** The old method of casting engine cylinders was to make them individual members. The new way is to cast 4 or 6 cylinders in one large casting to make a more compact design, all cylinders having a common water jacket and, in some cases, one large removable cylinder head.

**Differential.** An assembly of gearing in the rear axle that permits the driving wheels to turn at different speeds when rounding curves. As the outer wheel covers more ground, it must turn faster than the inner or pivot wheel, and, at the same time, the power of the engine must be delivered to each wheel in proper proportion. If no differential gear was fitted, there would be considerable wear on the tires, as the difference in wheel speed would result in the tires slipping.

**Ignition.** In order to produce power the explosive gas in the cylinders of the engine must be exploded at the proper time, so that the piston will be forced down in the cylinder by the expanding gas. The electric spark employed to fire the charge is termed the *ignition spark*, and the electrical appliances producing it are parts of the *ignition system*.

**Knocking or Pounding.** A sharp, metallic, clanking noise in the engine while running, indicating a loose bearing or other interior part of the mechanism, or serious engine overheating because of poor cooling or failure of the lubrication system to act. It is often caused by carbon deposits in the combustion chamber of the engine.

**Magneto.** A simple form of dynamo that produces electric current for ignition purposes and that may time it and distribute it to the cylinders so that they will fire in regular sequence. A simple device for converting mechanical energy into electricity. It can be used in place of batteries in the ignition system.

**Misfiring.** Irregular engine action, in which the cylinders do not fire regularly, due for the most part to faulty carburetion or ignition. It is accompanied by considerable vibration and loss of power.

**Over-size Tires.** Tires that are larger than standard rim sizes but which will fit rims intended for smaller tires when such are overloaded. For example, the oversize casing 33 inches by 4 inches is intended to go on a rim designed for 32 inches by 3½ inches casings. Over-size tires give longer life, reduce chances of tire trouble, and contribute to easier riding.

**Suspension, Three-point.** An engine can be held in the motor car frame by 3 or 4 supports. When held by 3 hangers, one is at the front end and in the centre, the other two are at the rear, one on each side. The other method is to use 4 hangers, one on each corner of the engine base. A 3-legged milking stool will rest more steadily on uneven ground than a 4-legged one. Similarly, a 3-point-supported engine will not be strained by frame distortion as much as one held by 4 points.

**Timer.** A mechanically operated switch driven by the engine and employed to distribute the ignition current to the various cylinders in their proper firing order.

**Torque.** The twist produced in a shaft or other member transmitting power. The greater the power transmitted at a given

speed, the greater the torque in the shaft. A measure of power introducing a leverage factor as the torque is greater at 1 inch from the shaft centre than it is at 6 inches from the centre. The torque is always less at the rim of a wheel than it is at the hub, assuming that the wheel is driven by the hub.

**Transmission, Planetary.** A form of change-speed gearing in which the gearing is so arranged that the speed-reducing gears surround the driving gear in the same way that various planets encircle the sun. The centre gear is called the "sun" gear, as it is the centre of the planetary system; the others are called "planet" gears.

**Transmission, Selective.** A form of change-speed mechanism in which sliding gears are meshed with each other, one set being carried on a main shaft, the other on a lay shaft. Various ratios of speed are secured by meshing together gears of different diameters. The selective system permits of engaging any desired pair of gears without first going through another ratio, as is necessary in the progressive system.

**Tread.** The distance between the points of contact of the front or rear tires measured along the ground and parallel with the axle corresponds to the "track" of a horse-drawn vehicle. The standard tread for automobiles is 56 inches.

**Universal Joint.** A form of driving coupling employed to join the engine to the rear axle driving shaft so as to allow some vertical and horizontal motion between the driving source and the driven member without straining the driving shaft or losing much power. An important part of all automobiles.

**Wheelbase.** The distance between the point of contact of the front tires and the ground and that of the rear tires and the ground. Moderate and long wheelbase cars are easier riding than short ones.

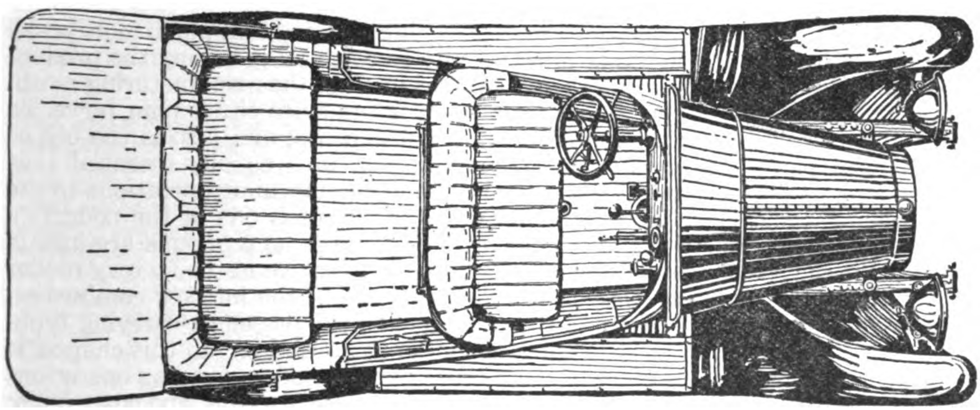


Fig. 68. Top view of a standard 5-passenger, left-hand-steering touring car body—an excellent all-round type for the farmer

FIG. 69. The motor truck enables the market gardener to make two or more trips to town where he used to make but one; and to meet special, profitable demands as he never could before

## CHAPTER 5

# Motor Trucks and Trailers on the Farm

AUTHORITIES on agricultural matters have computed that much more power is needed to carry on the farming operations essential in raising the produce required to feed our population than is utilized in all of the manufacturing establishments of this country. It has been many years since either man power or animal power was used in our industrial establishments; and just as the use of mechanical power has modernized manufacturing, it is equally essential that wherever possible mechanical power be used in modern farming operations to the exclusion of hand labor or animal power. Agriculture is one of the country's most important industries and it is evident that the same economic arguments that make the use of power-operated machinery imperative in the factory render it of equal importance on the farm. The wide use of the internal-combustion engine for power on the farm and the usefulness of the passenger-carrying types of automobiles are fully considered elsewhere in this treatise. In this chapter it is proposed to outline the place of the motor truck in modern farming operations and the farm work for which it is best fitted. Various types, sizes, and costs will be considered briefly, and endeavor will be made to outline some of the salient points to be considered in properly maintaining the motor truck.

**Gasoline engine easy to master.** Mechanical transportation has been made possible by the great development which has taken place in the last decade and a half in the internal-combustion, or, as it is familiarly called, the "gasoline" engine, and especially in its application as a propulsive agent for all types of motor vehicles. The big advantage of this type of prime mover is that it can be mastered by any person having the slightest knowledge of mechanics, and as most farmers are naturally mechanical they should experience no difficulty in obtaining from motor vehicles service more than commensurate with the amount of money invested in them.

The work such vehicles are doing on the farm is apt to be judged more by the spectacular performances or the unusual tasks than by the every-day, humdrum work that must be done regularly and as a matter of routine. Transportation is one of the daily tasks of the farmer that lacks the spectacular element, and for some time it was the one branch of farming that was neglected. Farmers who had thousands of dollars tied up in farm machinery that was used only at certain

seasons of the year hesitated to invest money in a motor truck that could be used at all seasons.

The early forms of trucks were far from being reliable, and it is only in recent years that a refinement in structural detail has made the heavy-capacity vehicles dependable and durable. Another factor that has retarded the adoption of the motor truck by the farmer has been the slow development of good highways in some sections of the country. In those states where improved roads are found, absolutely no difficulty has materialized that would prevent the economical use of motor trucks. Indeed, the one essential that controls the amount of service to be obtained from any truck is good roads, so that in districts where the highways are of an indifferent character the farmer will need to give the matter of purchasing a truck of conventional design very careful consideration. Still, even if road conditions are not of the best a motor truck will give good service, and special forms such as the 4-wheel-drive and types using the "caterpillar" tread or track-laying method of power transmission may be used under conditions that would stall the conventional 2-wheel-drive form of trucks. In some sections of the country it is possible to use mechanical power exclusively; in others the motor truck will prove practical for certain tasks and horses better adapted for others; and there are sections where a motor truck would not give satisfactory service and where animal power would have to be depended upon entirely.

**The ideal motor truck.** The tasks of the farmer are many and varied. Considerable work must be done during relatively short periods and only at certain seasons. The method of transportation used must be one that can be employed in various kinds of farm work, besides hauling produce to the market and returning with the supplies that are necessary to carry on the farm operations. The ideal motor truck for the farmer must be essentially simple in construction, easy to operate and care for, and economical to maintain. The motor truck has the advantage over animal power that it does not entail any maintenance expense except when actually in use and that it is ready for any task at short notice. When horses are used, unless some are held in reserve, it is not possible to make more than one trip to town and back if a farm is located outside of a radius of 10 miles, and generally the greater part of the day is consumed in making that one trip. With a motor truck several trips can be made, if necessary, in the same time, and if the work can be accomplished on one trip, it is done in so much less time that a longer period is available for doing other necessary tasks. All farms do not need gas tractors, but it is safe to say that almost any farm can use a motor vehicle to advantage. One feature is that on occasion motor transportation can be used by the women of the farm as well as by the men. The automobile truck brings the farmer closer to his market and greatly increases the radius of the circle of markets for the sale of his produce.

**Choosing a truck.** The important point to consider in selecting a motor truck for farm use is the character of the work it is expected to do. It would be inadvisable to purchase a large truck if the work could be done with a small one, and it would be a serious mistake to purchase a truck of less capacity than needed and overload it in attempting to make it do work that it was not intended for. On small farms, such as those devoted to the raising of poultry or dairy products, it is not necessary to use large trucks. A safe criterion to go by in selecting a truck is the number of horses that would normally be required to do the work expected of the motor vehicle. A 1-ton truck of good design will do the same amount of work as 3 horses in the same time, provided that conditions are favorable to the use of motor trucks. It is stated that the average work of a team of horses used for transportation purposes is about 20 miles a day. A truck can easily cover twice that mileage, and in emergencies 3 times the distance can be covered.

A 2-ton truck can do the work of 6 horses in many lines, and in a few, such as hauling, under good road conditions it can do more. As a rule, a 2-ton truck compares very favorably with 6 horses. While it is difficult to give maintenance figures that will apply to all localities for either the upkeep of horses or for

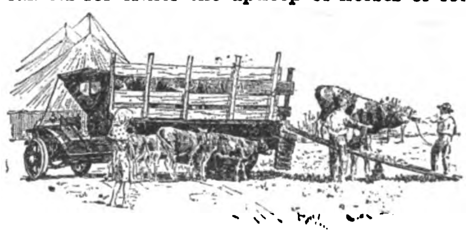


FIG. 70. The breeder who takes his stock to fairs and shows by truck avoids the expense, trouble, and danger of infection involved in railroad transportation.

that of motor trucks, it is safe to say that it will cost at least $5 per day for 1 team capable of traveling 20 miles. This is equivalent to 25 cents per mile. A consideration of the operating cost of various types of trucks shows that a 2-ton truck will travel 40 miles a day without difficulty at a cost of operation, including depreciation, maintenance, etc., of about $8 per day. If the truck travels 40 miles, the cost is about 20 cents per mile. A 2-ton truck will easily average 40 miles a day; in fact many are making 60 miles and more. Most of the cost figures given in the past have been based on the use of gasoline as fuel; but many trucks of recent development operate satisfactorily on the cheaper products such as kerosene or distillate, the latter being a very plentiful and common fuel in the western states, while the former can be easily obtained anywhere in this country.

**Why motor truck is displacing horse.** The reason that the motor truck is displacing the horse wherever mechanical power can be used is that it is now unprofitable to keep horses owing to the increase in their cost—about 150 per cent during the last decade. The maintenance expenses, also, have all increased, the cost of feed, harness, shoeing, barn construction, and other incidental expenses having become greater. In spite of the increased cost, the horse of to-day is no more powerful than that of 25 or 30 years ago, when horseflesh was cheap. Thomas A. Edison says that the horse is the most inefficient power producer known and the poorest motor ever built. Its food consumption is 10 pounds for every hour of work and the average horse eats 6 tons of food per year. In fact, it consumes the entire output of 5 acres of land. Its thermal efficiency is very low, that is, the amount of power obtained for the food consumed is but 2 per cent. Compare this with the power plant of the average motor truck, which has a thermal efficiency of 25 per cent in most forms, and it will be evident that the user of mechanical power has a pronounced advantage.

Analysis of a recent government report shows that a farm horse averages less than 4 hours' work per day, and that from tiring his efficiency is greatly reduced in 5 or 6 hours. A motor truck can be operated continuously. It has been stated that if the food required by the horses and mules now being used in the United States were raised on one large farm that this would have an area as large as Indiana, Illinois, Iowa, and Ohio combined. It is evident that in periods of food shortage this area could be used to much greater economic advantage in feeding our population than in providing fuel for inefficient animal power.

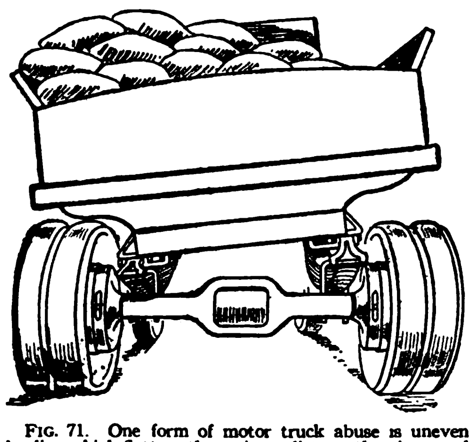


FIG. 71. One form of motor truck abuse is uneven loading which flattens the springs, distorts the tires, and often results in serious upsets.

The farm horse is a contemporary of the spade and the scythe. The motor truck is a contemporary of the tractor plowing outfit and the automatic binder and harvester. Horses that are used with great care will not work more than half of the working days of the year, and if more service than this is expected, it can be done only at the expense of the animals' endurance. If a motor truck is taken care of, it will be in working order about 85 per cent of the time, if one considers the time lost in maintenance and in making necessary repairs. It should be borne in mind that in this period the motor truck may be worked 24 hours a day, if necessary. Another consideration which shows an important difference between a living organism and a mechanical contrivance is that a horse is depreciating in value, that is, he is growing older all the time, even if most of that time is spent in a stall. The motor truck depreciates only when in use, as when it is idle there is practially no expense to be considered except the cost of storage and the interest charges on the investment.

The mistake that is often made by the farmer who contemplates using motor trucks is that he compares motor-truck service with his previous experience in using animals, and in so doing he is apt to lose sight of the many marked advantages that a motor truck has over the horse in the field of transportation.

As regards the comparative cost of maintaining horses and trucks, it has been found that, when all of the expenses of a light double team for 1 month were considered, the average miles per day numbered but 12 and the cost per mile was 38 cents. One heavy double team made 10 miles per day average and cost 64 cents per mile to operate. A 1½ -ton motor truck averaged 36 miles per day and cost 23½ cents per mile to operate. A 3-ton motor truck averaged 30 miles per day and cost 36½ cents per mile. The costs per ton mile (that is, per ton of load hauled one mile) were respectively 36, 32, and 12 cents.

**Types and sizes of trucks.** It is not possible to give an opinion as to the best size of truck to use on a farm of certain acreage, because the nature of the work done on two farms of identically the same size would vary widely according to the section in which they were located, the character of the soil, and the possible market for the product. Some small farms are cultivated intensively and raise garden truck for city markets in such large quantities as to make the use of a motor truck imperative. Motor transportation not only insures the prompt delivery of perishable products, but makes it possible to seek a market farther away than the original one, if it is found that an unusual quantity of the same class of produce has been brought in. A farm producing a bulky product would require a larger motor truck than one of the same size which shipped its product in a more concentrated form, such as a milk or a poultry farm. The best way to determine the most useful size of truck is to compare its prospective work with that accomplished by horses, bearing in mind the fact that on many farms it will still be necessary to keep some of the animals for work that a truck is unable to do as cultivating, pulling mowing machines, hauling over meadows and through roadless fields and forests, etc.

**Types and their cost.** The types of trucks available, their initial cost and maintenance expense, vary as widely as the character of work these trucks can do. On a small farm where no more than 2 horses are kept for transportation it may be possible to dispense with both animals and replace them with a small truck of about 1,500 pounds capacity. As a general rule, trucks having a capacity ranging from 500 pounds to 1,500 pounds are usually converted standard passenger-carrying chassis that have been fitted with light bodies of the express type. Small trucks are generally equipped with pneumatic tires, and most of them have about the same speed as pleasure cars of equal power and cost but little more to operate. A light vehicle of this form having a capacity of 750 pounds will cost about 7 cents per mile to operate, this including cost of tires, depreciation, and interest on the investment, as well as the cost of fuel and oil. The mistake is often made by truck salesmen of quoting figures considerably lower than those of the actual maintenance cost, only such items as are apparent, as fuel and oil consumption and tire depreciation, being considered. The truck purchaser expects to duplicate the figures given by the optimistic salesman and is disappointed when he finds that the actual operating expense is two or three times what he has been expecting.

No figure is given for repairs in the estimates considered because this is an unknown factor in which the personal element enters. The depreciation considered is only normal wear and tear, and it is considerably lower than it would be if a truck were carelessly operated, poorly inspected and lubricated, and continuously overloaded. The average of a set of maintenance figures shows that the cost of running the average light truck of 1,500 pounds capacity is between 12 cents and 14 cents per mile. Trucks having a carrying capacity of 1 ton or more are usually built along lines that are a departure from those used in passenger-carrying chassis. All of the parts are more substantial; and special features of truck construction are noticed, such as heavy frames and springs, more substantial wheels and axles, the use of hard rubber tires instead of the pneumatic types employed on the lighter trucks, special power-transmission systems such as worm and internal gear drive and, as a concession to the

FIG. 72. Modern devices for hitching an ordinary wagon to a pleasure car provide increased hauling capacity at minimum cost.

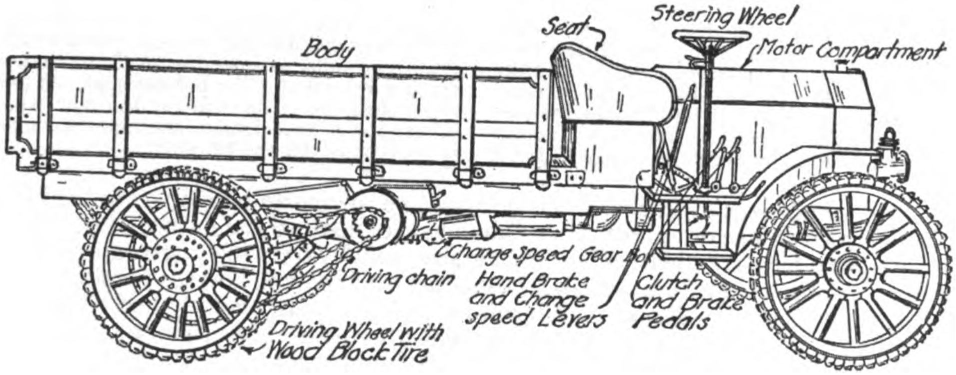



FIG. 73. A good heavy farm truck of the chain drive type

heavier load, the less resilient springs and the solid rubber tires, a materially reduced maximum speed of operation. When solid tires are used the factor of tire expense is reduced, but that of mechanical depreciation is increased. The cost of operating a 1-ton truck of real truck construction will not be very much more than that of the converted pleasure-car chassis of considerably less capacity, and it is safe to figure on about 20 cents per mile as the operating cost.

As trucks augment in capacity there is not a directly proportional increase in operating expense, because there is very little difference in the size of the engine used in a 1-ton truck and in one of twice that capacity. The increase in weight is compensated by gearing the truck lower and reducing its speed. In this way the power plant will use but little more fuel and oil than in the lighter truck, and instead of the cost of operation being twice as much for a 2-ton truck as it would be for one of half the capacity, the increase in cost is but 33⅓ per cent., or about 27 cents per mile for the 2-ton job. A good 2,000-pound capacity truck can be purchased for $1,500. A reliable truck of twice this capacity may be purchased for approximately $2,000. Hence, it is economy to purchase a truck somewhat in excess of the actual requirements rather than one of just the capacity needed. In figuring the probable cost of operation of trucks of greater capacity than 2 tons one need only add 5 cents to the basic figure of about 30 cents per mile for each 1,000-pound increase in truck size. A 3-ton truck therefore would cost about 40 cents per mile to operate. Truck operation figures can be kept to a minimum if the work done is intelligently planned so that return trips can be utilized instead of bringing the truck back from market empty. The cost of truck operation has been materially reduced by many farmers who have brought supplies back from town for their less fortunate neighbors at a nominal figure rather than drive the truck home empty.

## Points of a Good Truck

There are certain characteristics which have become standardized on practically all trucks of modern manufacture. Of the converted pleasure cars but little need be said here, the characteristics of the passenger-carrying automobile having been fully considered in their proper place. Practically all trucks, regardless of capacity, are now provided with 4-cylinder 4-cycle engines of the water-cooled form. While a truck engine is similar in principle to that used on a pleasure car, it is considerably heavier, and the parts are of more substantial proportions because the engine is of a medium-duty type rather than of the light-duty, high-speed type that can be used successfully in passenger-carrying vehicles. The bearings are of greater area because they do more work, and the cooling system has more of a margin regarding heat-absorbing capacity when used on a medium-duty power plant. At the same time, the construction of a truck engine is not nearly as heavy as that of a tractor power plant or of an engine intended for stationary work.

**Position of power plant.** There are two methods of placing the power plant relative to the operator's seat. In all types of commercial vehicles the motor is installed at the front end of the chassis, and in some cases it is under a hood as in pleasure cars, but in other designs it is placed under the floor boards or the driver's seats which are elevated for that purpose. Most of the modern trucks have the engine located under the hood. The advantages of the motor-under-the-seat location may be well summed up by saying that it makes possible more loading space for a given carrying capacity and wheelbase. The shorter wheelbase vehicle has advantages, if it is to be operated in congested city traffic, as it is more easily maneuvered when driving in narrow thoroughfares, taking corners, or backing up to a loading platform. The main advantage advanced for the motor-in-front

type of trucks is accessibility of the power plant, which may be easily reached by raising the hood. This feature is by no means lost when the motor is placed under the seat, because all average adjustments may be easily made by raising the floor boards or by opening hinged doors which are placed at the side of the motor compartment. Some makers who install the motor under the seat arrange the parts in such a way that they may be removed as units, permitting ready access to the motor and making for prompt removal in event of overhauling. In such a truck, a dash unit which includes the radiator, control levers, fuel tank and a frame for the support of the floor boards may be removed after a seat unit, which is separate and designed to fit over the dash unit when that is in place on the chassis, is taken out of the way.

**Combination motor truck and tractor.** For farm use, combination vehicles which incorporate some of the features of the motor truck in conjunction with those of the tractor have been favorably received by farmers. The farm truck (Fig. 73) is a very good form for general use. It is said that it will carry a load of 3 tons in the wagon bed and that it has a drawbar for pulling plows and other machines requiring draft. A pulley is located at the front end for driving stationary machinery. The weight of this truck is carried on four wheels, and, when used as a tractor, a load must be placed over the driving wheels to secure proper traction. The machine is spring-mounted and is adapted to speeds ranging from 3 to 15 miles per hour. It may, therefore, be used for a wide variety of work. The wheels may be provided with solid rubber tires for ordinary road use or with a series of wooden plugs to adapt the tractor to field work. Traction on soft ground may be secured by an extension rim having a number of mud lugs attached, these being so fastened to the wheels that they will automatically grip the soil when the wheels sink to a certain depth. A machine of this nature will haul grain, hay, stock, milk, fruit, vegetables, or any kind of farm produce to the market, and it will bring back coal, lumber, fertilizer, or any other kinds of merchandise needed by the farmer. Provided with a 40-horse-power motor, it has sufficient tractive power to pull three 14-inch plows and a harrow in ordinary stubble plowing and will complete an acre per hour. It will pull 2 discs or 2 spike harrows, 2 seeders, 2 binders, corn planters, a road grader, a train of loaded wagons, or any other machinery that does not require a draft greater than that furnished by 10 horses. A general-purpose machine of this character is a valuable piece of equipment for both small and medium-sized farms, as it will not only haul loads of all kinds in its wagon bed but also can be used for field work to some extent and serve as a portable belt power plant when desired.

While the conventional rear-wheel-drive truck is adequate for fully 75 per cent of hauling requirements, there are conditions where the use of a 4-wheel-drive truck would be advisable. In this machine all 4 wheels combine directive as well as tractive functions, which means that they are all movable for steering purposes and are driven by the engine power for transmission purposes. Inasmuch as a separate brake is provided on each wheel and a special form of differential is employed that delivers the power to the wheel having the greatest traction, it is hardly possible for this truck to become stalled in mud or sand, and it is practically impossible for it to get out of control. The four-wheel-drive principle is especially valuable if the truck is to be used for hauling trailers or for doing other drawbar work.

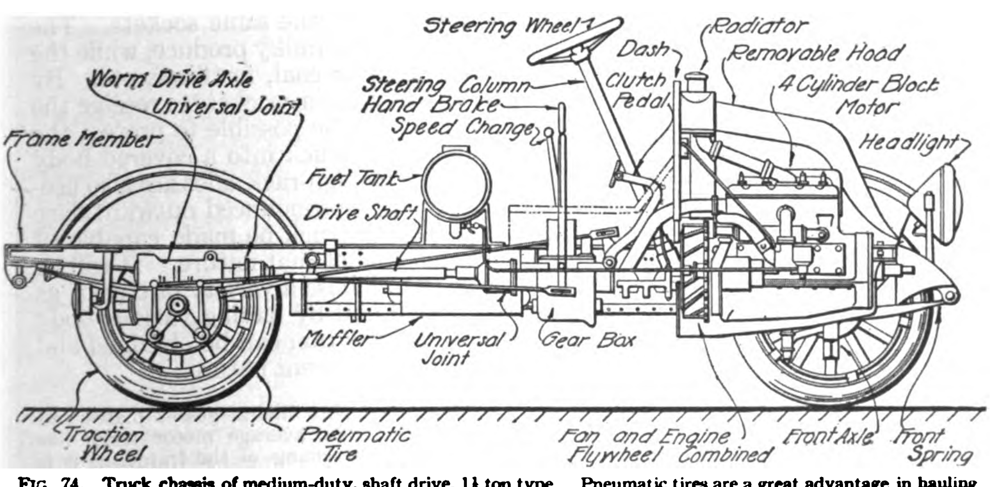



FIG. 74. Truck chassis of medium-duty, shaft drive, 1½ ton type. Pneumatic tires are a great advantage in hauling eggs, fruit, and other easily injured products

A very popular form of truck tractor has the conventional front-wheel construction, but has the rear traction members in the form of 2 endless treads or flexible steel tracks passing over wheels and therefore lays its own road as it goes along. These treads offer a much larger area of contact to support the weight, and for that reason they are much better suited for work on soft ground than the usual truck wheel would be. There is considerable mechanical friction, and this form of drive is suited only to low-speed vehicles intended for use on the field rather than on the road. Various attachments for the conversion of low-priced pleasure-car chassis into trucks of 1,500 to 2,000 pounds capacity are marketed, and when these are used it is possible to obtain a 1-ton truck by such conversion for less than $700. These attachments can be regarded only as a makeshift, however, and the converted job cannot in any sense of the word be considered equal in strength, durability, or reliability to specially designed trucks intended for commercial work only.

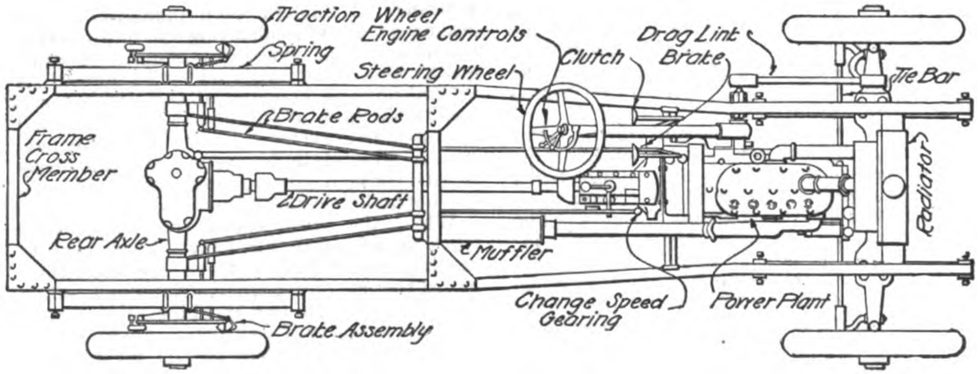



FIG. 75. Truck chassis built on pleasure car lines, for light and relatively fast farm work. Compare with Fig. 76

**The best truck to buy.** The best type of truck for the farmer to buy is one built on truck-engineering principles rather than the types that follow pleasure-car practice. There is a wide range of body designs for the farmer to select from. For general use, the express-type body is perhaps the most useful, but for trucks of more than 2 tons capacity the writer would recommend a platform-type body to which the type of siding best adapted for the work in hand may be easily attached. For certain work, such as hauling farm machinery, stationary engines, etc., stakes would be all that would be needed. High-rack sides or express-body panels could be easily installed in place of the stakes and in the same sockets. The former could be used in transporting relatively light but bulky produce, while the latter could be used for the heavier materials such as coal, fertilizer, etc. By having detachable bows, as on an army wagon, and by having sockets to receive the bows attached to the high racks at the sides, it would be possible to protect the load with a large tarpaulin cover and transform the truck into a covered body patterned after the old prairie-schooner design. The high-rack sides are also useful in transporting livestock. Special racks having a pronounced outward flare can be employed on the common wagon bed and the truck be made capable of carrying a heavy load of hay, straw, or other material of that nature. It will be evident that it is not necessary for the farmer to purchase a variety of trucks, as by standardizing on a simple platform-bed design and by having various body sides that can be attached at will, almost any combination can be obtained and the same truck used for carrying materials of widely different nature.

Instead of using the lighter forms of pressed-steel frames, as in pleasure-car practice, the average motor truck employs steel I-beams or channel sections which are well braced by substantial cross members of the same form and provided with liberal gusset plates and brace bars. The average motor truck has considerable overhang of the frame, as it is desirable not to have too long a wheelbase, and yet it is not considered advisable to sacri-

fice on the load-carrying platform. While the unit-power-plant construction, in which the change-speed gearing and the engine are combined in 1 unit, is very popular in pleasure cars and the lighter trucks, in practically all trucks of large capacity the change-speed gearing is placed amidships or located in such a way as to make possible the use of shorter driving shafts than would be the case if the gear box were placed well forward. This construction is well shown in the view of the large-capacity chassis (Fig. 76) which also outlines the conventional disposition of the important components and which details the pronounced overhang of the rear end of the frame.

Formerly, chain drive was very popular, but practically all trucks of modern development use shaft drive, the rear axle having a single worm and worm-gear reduction, or, in the composite-axle type, the truck may have a double-gear reduction in which the primary reduction of speed is through bevel gears, while the secondary speed reduction is secured between spur pinions on the ends of the axle shafts and the large internal gears attached to the wheels to which the final delivery of power is made. Chain drive has important advantages, one of which is that it is possible to obtain different final gear reductions to suit different operating positions. This is a very difficult thing to do with any other form of final drive. If a chain-driven truck is to be used for carrying heavy loads or for drawbar work, it is possible to reduce materially the gear ratio and increase the draft by substituting smaller drive sprockets on the truck countershaft. If the working conditions are less severe, and more speed is desired, the small sprockets may be replaced by larger ones.

The usual ratio of final drive on light trucks is about 8 turns of the engine crankshaft for each revolution of the rear wheels. On heavy trucks the reduction on the direct drive may be as high as 15 turns of the engine to 1 revolution of the rear wheel. In order to prevent overspeeding, which is detrimental to the endurance of the truck mechanism and results in rapid depreciation of the power plant, automatic governors are fitted to the engine to restrict it to a certain definite speed which cannot be exceeded. On the lighter trucks 3 forward speeds and 1 reverse are considered sufficient in the gear set, but in the change-speed gearing of heavier trucks, 4 forward speeds and, in some cases, 2 reverse speeds have been provided. The spring suspension of practically all motor trucks is the same, as semielliptic springs are used on both front and rear ends. This is the simplest and strongest form of spring, and it is very easy by watching the deflection of the spring to determine whether or not the truck is overloaded.

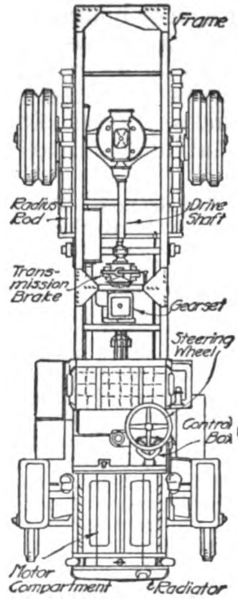


Fig. 76. Chassis of heavy, double, wheeled, shaft-driven farm or commercial truck. One of the essentials of profitable truck operation is good roads.

## Care of the Truck

**Avoid overloading and overspeeding.** Overloading and overspeeding are the two most common causes of rapid truck depreciation. Both of these faults are often noticed in combination, producing doubly injurious results. While most trucks are designed to withstand a certain margin of overload, it is not advisable to load them beyond their capacity, except in an emergency when this is unavoidable. Overspeeding is a result of carelessness and should never be tolerated. In driving a truck, especially a loaded one, the operator should bear in mind that a very large mass is in motion and that it cannot be easily stopped if a sudden halt is to be made, and that it should not be allowed to attain high speed when descending hills, as it may get out of control. Considerably more care and judgment is needed in driving a truck than is usually exercised in operating passenger-carrying vehicles. It should be remembered that the load is carried on stiff springs which cannot have any great degree of flexibility or a large radius of action without being seriously weakened, and that the hard rubber tires with which most trucks are provided do not shield the mechanism from road shocks as much as pneumatic tires do on the lighter vehicles. This means that when a truck is operated on

rough or bumpy roads it must be driven carefully and slowly, if rapid depreciation of the mechanism is to be avoided. More trucks are worn out from abuse than by normal use. Because of the severe vibratory stresses that are present in the truck mechanism it is necessary that these be inspected very frequently and any loose bolts, nuts, or other fastenings be tightened. It is also important that lubrication of the chassis parts be carried out systematically.

**Lubrication.** The average truck owner is not apt to overlook the lubrication of his engine because, for the most part, automatic lubricating systems are provided which call only for replenishing the oil supply from time to time on the part of the operator. There are numerous points about the truck chassis that are apt to be neglected. The manufacturer of the truck has provided compression grease cups at all of the principal points, and it is important that these be screwed down periodically to supply grease to the parts that carry considerable load even though the motion is relatively slight. For example, beginning at the front of the truck one will find grease cups on the front spring supports and on the rear shackles of the front springs. These are intended to lubricate the spring-supporting bolts which are subjected to a heavy, continuous load all the time the truck is in operation. It is seldom that these points receive adequate attention, and the result is that the bolts wear out very quickly.

The steering knuckles on the front axle and the various joints on the tiebar which joins the two steering knuckles and those on the drag link which connects the steering arm on the front axle to that of the steering gear, are also continually in action while the truck is being driven, and should receive copious lubrication by screwing down the grease cups every 2 or 3 days if the truck is continually in service. Similarly, the rear spring shackles and shackle bolts need this attention. A number of grease cups are placed on parts of the mechanism which are easily reached without getting under the truck. These should never be neglected; they should, on the other hand, be inspected regularly and frequently to make sure that the parts are getting enough grease. Whenever a more thorough inspection is made for loose parts or fastenings, special care should be exercised to lubricate the inaccessible points as well as those that are easily reached.

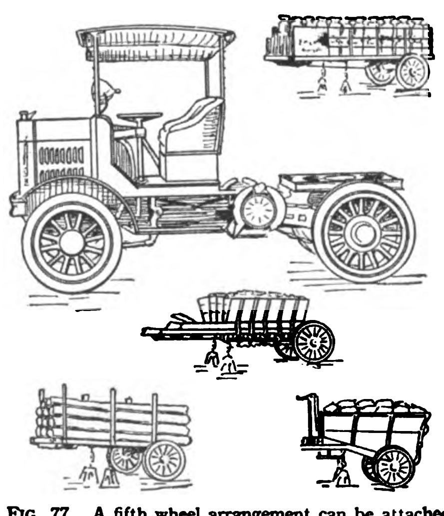
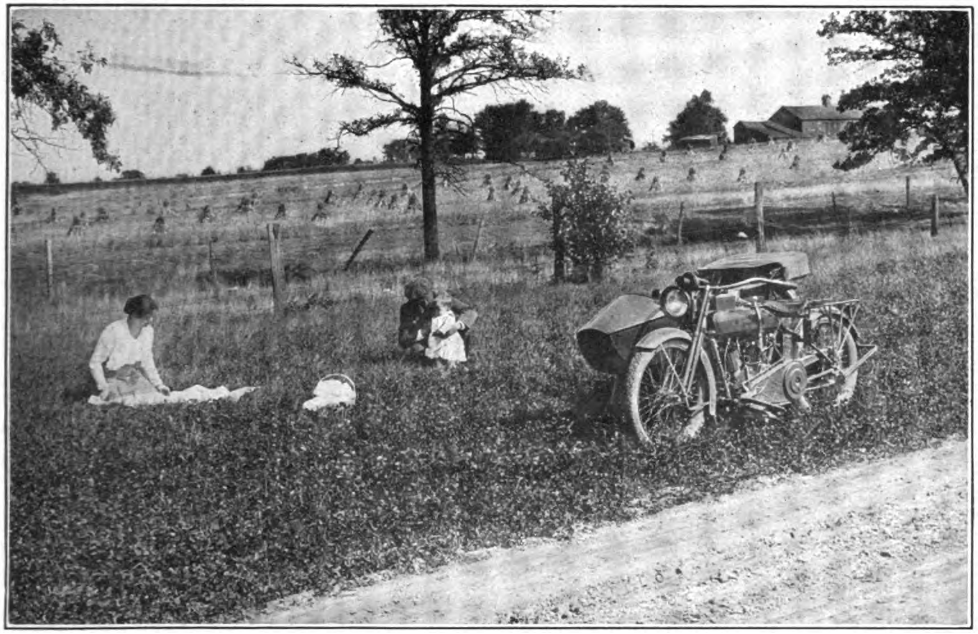


FIG. 77. A fifth wheel arrangement can be attached to the chassis of either truck or pleasure car so as to provide motive power for any number of semitrailers to be used one at a time. This enables one load to be hauled while another is loaded or unloaded.

**Frequent inspection.** It is desirable to make a thorough inspection of the mechanism at least once a weak, if a truck is in constant use. One cannot give too much care to the inspection and adjustment of such important control elements as the parts of the steering system and the brakes. Brakes must be kept properly adjusted, so that the truck can be brought to a stop without the expenditure of too great effort on the part of the operator. At the slightest suspicion of depreciation in the brake linings or in the brake-operating linkage, prompt steps should be taken to supply new parts. It will be advisable to lubricate the spring leaves from time to time, as, if this precaution is neglected and the springs get rusty, broken spring leaves will result. Special tools are procurable for spreading the spring plates apart when the spring is relieved of the truck load by jacking up under the frame, and the lubricant, which is graphite grease or graphite and oil, can be introduced without difficulty. The change-speed gearing, the differential casing, and the wheel bearings of practically all trucks are so housed that a large quantity of grease may be packed in to insure lubrication for extended periods.

**Shelter.** The one point in the care of their motor trucks, tractors, and other farm machinery about which nearly all farmers err is in not providing sufficient protection from the elements. Items of equipment that represent considerable money outlay are allowed to stay out in the weather, sometimes because of lack of space for their storage and at other times through sheer neglect. It is not uncommon for the traveler through our agricultural sections to see mowing machines, hay rakes, plows, harrows, and similar farm machinery lying in the fields at seasons of the year when they should be under cover. The farmer who



**The motor cycle is a splendid emergency work vehicle, but it often renders its greatest service as a source of pleasure**

**While the automobile is primarily a pleasure vehicle it often becomes invaluable in supplementing the farm's work-horse power**

**THE MODERN MOTOR VEHICLE HAS WON ITS HIGH AND PERMANENT POSITION IN THE FARMER'S ESTEEM BECAUSE OF ITS DUAL PURPOSE NATURE**

**The logical place for the truck is on the road, where long, heavy hauls, in order to be profitable, must be made swiftly**

**But here, as in the automobile, elasticity of usefulness makes it available for occasional field work as well**

**THE BETTER THE FARMER KNOWS HIS MACHINES AND VEHICLES, THE FARTHER HE IS ABLE TO EXTEND THEIR RANGE OF USEFULNESS**

does not provide proper housing facilities for his motor trucks will have to pay maintenance and repair charges out of all proportion to the work accomplished by the machines. An automobile contains considerable machinery which may not be exposed to the weather with impunity, as serious trouble will develop in the ignition and carburetion systems if these become water-soaked. Brightly polished metal parts will rust, and dampness will cause corrosion or rusting of parts that will not function properly unless they are clean.

**Truck should have special garage.** Any farmer investing in a motor truck should provide a special garage in which it can be properly cared for, and should not house it in any shed or stable as he has been accustomed to do with his other rolling stock. A motor truck must be cared for. From costly experiences in the past, the farmer who neglects his horses knows what to expect. Many believe that inasmuch as a motor truck is machinery it needs no care. It has been stated that the chores incidental to keeping a horse in condition consume about half an hour per day per horse, which is equal to about 20 full, nine-hour days in a year. This same amount of time intelligently spent in a motor-truck upkeep will enable the user to obtain reliable service from a machine that may replace from 3 to 8 horses. The garage for the motor truck should be well-

FIG. 78. Convertible body attached to a light truck. This basket rack body, especially fitted for hauling fruit and truck crops has a one-ton capacity.

lighted, have a concrete floor, be provided with a workbench and a complete set of tools for proper truck upkeep, and must be dry. If the motor truck is kept in such a workshop the work of upkeep will be pleasanter. If a truck is kept in a tumbledown, leaky shed or outhouse there will be no inducement for working on it. Many odd jobs can be done on rainy days, if the truck is properly housed. All of the tools used in motor-truck upkeep are equally useful in the repair and maintenance of other farm machinery, so that the amount invested in a complete mechanical equipment is money well spent, and the returns are usually large when compared with the investment.

## What Trailers Are and How to Use Them

The capacity of any automobile can be greatly increased by using a trailer, and on many small farms the indispensable pleasure car can be utilized to good advantage and made to do useful work by using it as a tractor for pulling a trailer. There are 3 forms of trailers devised for use with automobiles. The simplest of these is the 2-wheel form which can be attached to the rear end of any pleasure car and which will easily carry loads ranging from 500 to 1,200 pounds. The wheels are placed at the centre of the body and will carry practically all of the load, if it is properly distributed so that the towing tongue or fastening is not loaded to any appreciable extent. These small trailers use artillery-type wooden wheels with solid rubber tires, and good springs, so that the trailer will ride easily. A small model, which has a capacity of 800 pounds, has a solid panel body, 51 by 72 inches with 10-inch high sides, and a 6-inch flare board. It weighs about 275 pounds. A 1,200 pound model has a stake body 4 by 8 feet with removable side and end gates. This larger trailer weighs about 350 pounds. In order to facilitate attachment automatic couplers are used which can be attached or removed in a few seconds.

The semitrailer type has but 2 wheels, and cannot be used without specially built tractors to support the front end. A very practical form of fifth-wheel arrangement is marketed which may be carried on the chassis of a light pleasure car when the rear portion of the body is removed, and with this combination the ordinary forms of farm wagons may be hauled by merely removing the front wheels and axle at the king bolt and attaching the king bolt to the special table, which permits of universal action, carried on the tractor. Special automobiles of short wheelbase pattern are used and are employed purely as a tractor unit.

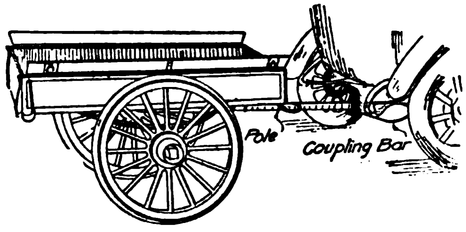



FIG. 79. With a two-wheeled trailer one can carry an extra load to or from town, or all the equipment needed for a ten days' camping out vacation.

For example, a truck chassis that would carry only 3 tons will haul nearly twice that weight if it be employed as a semi-trailer-tractor combination.

Another form of trailer is a 4-wheel type having all wheels carried on steering knuckles so joined by interconnected levers and drag links that the wheels will track when rounding corners. This is a very useful feature, making it possible to use several of these substantial trailers so that they will form a road train behind any motor truck or tractor providing the required draft. With this construction, the trailers carry all the load, and the towing truck is called upon to carry only that portion of the weight which is loaded into the body to secure adequate traction. In the semitrailer form it is evident that a portion of the load must be supported by the tractor rear wheels, so that what we really have in this combination is a 6-wheel automobile so jointed in the middle that the front and rear may assume different angles to make steering easier or to compensate for inequalities in the road surface.

**What a truck can haul.** The amount of load a truck can haul on a trailer depends entirely upon the road conditions, and as a general thing it may be stated that any truck of good design will pull over reasonably good level highways, a loaded trailer having the same capacity as the rated load of the towing truck. Of course, on sandy roads or in country where there are many hills it would not be possible to use a trailer nearly as heavy as could be employed under favorable conditions, and it is conceivable that motor trucks may be employed under such conditions that would make it impossible to use a trailer. Considerable judgment is needed in this regard, and before purchasing a trailer of the heavier types it will be well to consult somebody familiar with motor trucks to make sure that the truck mechanism would not be unduly stressed if a loaded trailer were attached to and drawn by the truck.

Some truck manufacturers have provided towing hooks and drawbar attachments and have strengthened the frame construction so that trailers may be used without injuring the towing-vehicle chassis. Certain road tractors have been contrived which are designed especially for trailer work. Some have winch attachments driven by the engine so that they can pull the loads slowly over poor roads and over grades where the truck would not have sufficient traction to haul them in the conventional manner. There is considerable difference in the road resistance of a good asphalt or hard gravel road, which will range from 25 to 50 pounds drawbar pull per ton to be moved, and an ordinary country sand road, which offers such resistance that 150 pounds pull per ton is needed, or a soft dirt road or one having sand 2 or 3 inches deep, which will necessitate a drawbar pull of 275 to 300 pounds. Chain-drive or internal-gear, double-reduction, axle-driven trucks are much better adapted for towing trailers than those provided with worm drive.

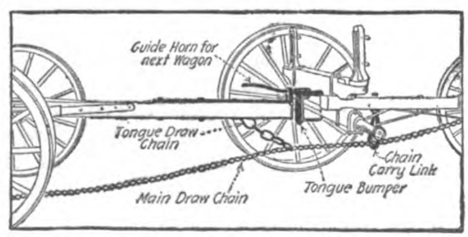



FIG. 80. A device for hitching up a number of trucks or wagons. The essential parts are shown in black.

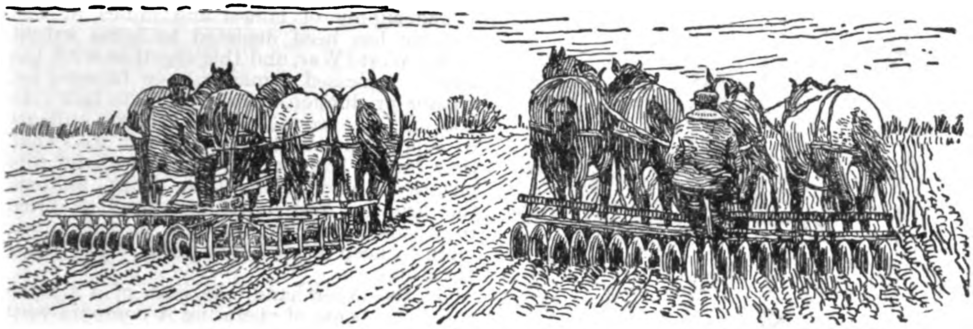


FIG. 81. The tractor is not going to replace the horse—entirely; but when nearly as much work as can be done by two men and eight horses (as shown here) can be done by an outfit such as that shown in Fig. 82 below, and in less time, it is fitting that the farmer should realize what the machine has to offer

## CHAPTER 6

# The Farm Tractor

*By* RAYMOND OLNEY, *Editor of "Power Farming," who was born and reared on a farm in New York State and later graduated from the mechanical engineering course of Cornell University. He then spent a season on a tractor experimental farm in the Middle West as tractor operator, attempting to determine to what extent a tractor is practical and economical for general-purpose farm work. Later he took a post-graduate course in agricultural engineering at the Iowa State College, at which time he was also employed as assistant in agricultural engineering of the Iowa Agricultural Experiment Station. Still later he spent a year and a half as power-farming expert for one of the large tractor concerns, and for the past 4 years has been engaged in farm-paper editorial work, specializing on the application of mechanical power to farming operations.*—EDITOR.

**REASONS for the tractor.** There is a real need on a very large percentage of American farms for the farm tractor. While it is not yet a perfect machine, there are several makes that are giving satisfaction. In spite of many weaknesses (which are naturally to be expected in any new machine), the tractor has proved itself sufficiently successful so far, and it is quite generally recognized as having come to stay. Machines are now being purchased each year by the tens of thousands, and this leads to the conclusion that there is a great, actual need of them.

The world need of an unfailing supply of food has resulted in a need of more power to produce it; and, because of labor and other conditions, farmers have been forced in thousands of cases to buy tractors to maintain the ordinary volume of production on their farms, to say nothing of increasing it. The production of food in the United States has not kept pace with the growth in population. During the past 10 years our population has increased about 29 per cent, while the production of wheat and corn has remained practically stationary, and that of meat has actually declined. Thinking men are beginning to recognize that mechanical power in the shape of the tractor is needed to help farmers increase production in proportion to the increased need of food by our own population, as well as that of foreign countries.

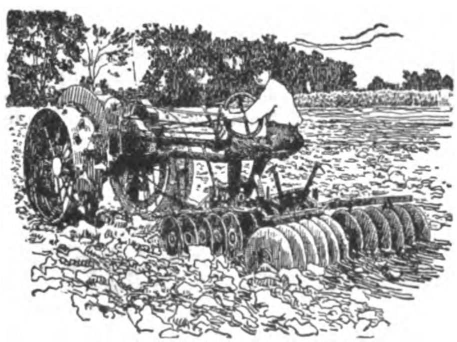


FIG. 82. Whether in peace time or war time, profitable farming demands all possible saving of man power

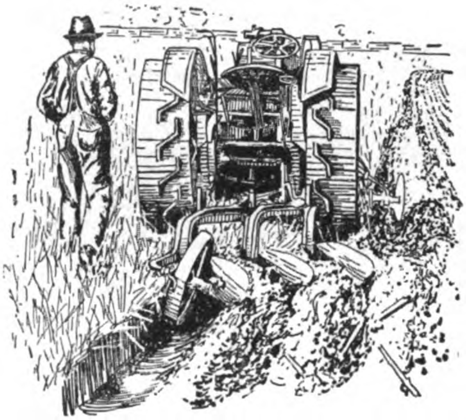


FIG. 83. A thoroughly efficient, correctly designed tractor, when rightly adjusted, should carry on its work under normal conditions without the need of man's guidance.

**The tractor and farm labor.** Probably the strongest evidence of the need of the tractor is the solution—partial, at any rate—which it seems to offer of the farm labor problem. It is not by any means a cure-all for the labor shortage, but it has certainly been the means of bringing relief to a great many farmers. Since purchasing his tractor, a certain farmer and his son have done the farm work more easily than ever before, and without hired labor except possibly for a few days at rush times when extra hands are always needed. This experience is similar to that of thousands of tractor owners.

The tractor makes it possible to get along with less help, because with the machine one man can direct easily and efficiently much more power than he could if he were using horses. A tractor that pulls 4 plows requires but one man for plows and all. The same plows pulled by teams would call for at least 2 men, and possibly 3 or 4, depending on whether the units were of 1 or of 2 plows each. For some jobs, particularly harvesting grain, one man is needed on the tractor and one on the implement or machine that is being hauled—in other words, an extra man is required. But this extra labor is being gradually rendered unnecessary, by improved attachments which enable the operator to drive the tractor from the seat of the implement being used.

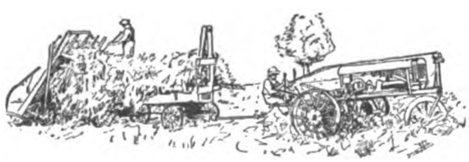


FIG. 84. The tractor may be used in harvesting a crop—

The supply of horses and mules in this country has been depleted to some extent by the World War, and this together with the greatly increased demands upon farmers for greater production, is revealing the fact that not only do we not have enough animals to supply the needed power, but also that they cannot be produced fast enough for this purpose. Aside from this, work animals the country over have increased in price to a considerable extent; also, it costs much more to keep a horse now than it did a few years ago.

On the other hand, the cost of a tractor and the expense of operating it compare very favorably with animal power. In some cases it has proved much more expensive than horses, while in others it has been cheaper. The expense varies, depending on a great many conditions. An advantage of the tractor, particularly at a time when there is an unprecedented demand for farm products, is that it can be produced quickly in large numbers; the annual output is even now reckoned in tens of thousands.

**The tractor and better farming.** Farmers who own tractors, with but comparatively few exceptions, are agreed that the machine enables them to do better farming. There have, of course, been many miserable failures, but these were not due entirely to the tractor. It is a fact that a suitable machine in the hands of a good manager will, especially in such work as plowing and preparing the seedbed, do better work than is possible with teams. If one is careful to get a machine that has plenty of power for the number of plows used with it, he can plow deeper than he would care to with horses. In disking and fitting the ground for a crop, which is usually horse-killing work, the implements may be adjusted and operated to do the work as it should be done without having to fear that the tractor is being overworked, provided, of course, it is not overloaded.

FIG. 85. —And then hitched up as a stationary engine to shred, thresh, or bale it

It is not alone the concentration of power in the tractor that enables one to do better farm work with it. The fact that, as a rule, the machine permits of doing the work at the

right time, when soil, weather, or crop conditions are just right, is a still more important factor. The work can be done at the right time, because the tractor usually works faster, in all kinds of weather, than horses, and, where desirable, it can be worked night and day by providing two shifts.

While the farmer may be able to do better farming with a tractor, the fact that it supplies no manure with which to keep up the fertility of his land must not be lost sight of. Furthermore, the wear and tear on implements used with a tractor is greater than with horses. These are important factors that prospective tractor buyers must consider.

Tractor enthusiasts have a great deal to say about the tractor permitting the farmer to handle a larger acreage with the same amount of labor. While this can be done successfully under good management, in not a few instances the attempt has resulted in disaster. Under no circumstances should it be undertaken if it involves lowering the quality of the work done, which too often has been the case.


FIG. 86. A small tractor is a great help in caring for farm roads

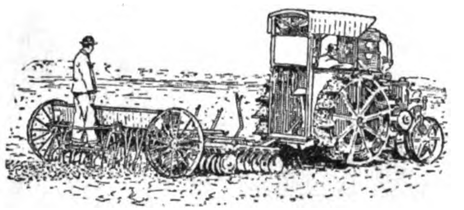


FIG. 87. Disking and seeding at one operation means maximum results just when they are most essential

**The tractor and larger farms.** It is true, however, that already the tractor has resulted in a tendency toward larger farms. In this connection a statement of Arnold P. Yerkes, assistant agriculturist in the United States Department of Agriculture in charge of tractor investigations, is of interest. He says: "The introduction of labor-saving machines has a tendency, other things remaining equal, to increase the size of our farms. This has always been true in the past and undoubtedly will be true in the future. Our investigations show that the tractor is having a decided influence in this direction. A large percentage of farmers, after purchasing a tractor, increase the size of their farms to a very considerable extent."

## Tractor and the Horse

Much as the tractor is needed on a very large percentage of farms, the time will probably never come when horses will cease to be needed to do farm work. In other words, the tractor has come to *supplement* animal power, not to *displace* it. There will no doubt be farms where horses can be dispensed with practically entirely; but these will be very few, and they will not be farms where a diversity of crops is grown.

There is need for both the horse and the tractor on most farms, as there is work for which one is better suited than the other. There are certain kinds of work, especially the light jobs, in which a team of horses is more flexible or otherwise better adapted than tractors as at present designed. In such work as planting and cultivating rowed crops, and in haying operations, such as mowing, tedding, and raking, horses are more suitable than most tractors; although there are a few machines on the market which are specially designed for the purpose, and which are proving very successful, particularly for planting and cultivating. The improvement in these machines has been rapid, and where any considerable amount of cultivating is to be done they will prove strong competitors of the horse.

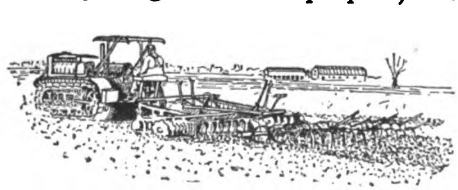


FIG. 88. The caterpillar type is especially valuable for fitting low, moist, soft land earlier than horses could perhaps work on it.

But even with new designs of tractors that are practical and economical for

FIG. 89. This tractor and this team are hauling the same amount of machinery, but the tractor can haul it for a longer time, can drive other kinds of machines between harrowing jobs, requires far less space and care when not in use and, ordinarily, will work day after day, in any weather without needing rest.

light work, there is still a place on the farm for the horse, for even in the case of tasks to which a tractor is suited, it is not good economy to use it for light work that teams will do just as easily, cheaply, and quickly, inasmuch as the teams have to be fed and cared for whether they are worked or not, while the tractor consumes fuel and oil only when it works.

**Advantage of tractor over horse.** Where the tractor has a distinct advantage over the horse is in heavy work; and one of the greatest things that can be said in its favor is that it is a very practical, effective means of relieving horses of the drudgery of farm work. Frequent stops for rest are always necessary in plowing and other heavy work when teams are soft in the spring or when the weather is hot. But with a tractor these are not requisite; for the machine never gets tired, and, if the work has to be rushed, the engine can be worked 20 hours a day as well as 10. The special advantage in this is that, when putting in a crop, for example, the owner of a tractor can make the most of favorable soil and weather conditions by working his outfit double time.

If on every farm there were kept as many horses as were required to furnish sufficient power at certain rush times, on the average farm there would be several head more than would be needed most of the time. Except for a few weeks each year, these extra horses would be an expense to the owner. It is the fact that more power is needed on most farms than is available, and here is where the tractor has solved many a perplexing problem. The tractor takes the place of these extra horses, and while not working it is no expense to the owner. An Indiana farmer on being asked how many horses his tractor displaced, said: "None at all. I did not buy it with that purpose in view. I wanted it to take the place of those animals I did not have and which I seriously needed, especially for the short, heavy season of spring plowing and fitting the ground for seeding."

The following is from a summary of reports received by the United States Department of Agriculture from 200 Illinois tractor owners, and represents the general opinion on the relative usefulness of horse and tractor:

"The tractor has not displaced horses to the extent commonly expected by purchasers, but its greatest advantage lies in the fact that it does the heavy work quickly, and thus completes it within the proper season, since it places at the farmer's command a large amount of power when needed."

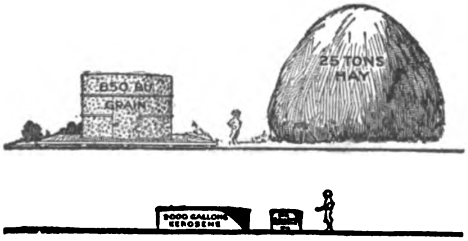



FIG. 90. Showing the bulk of a year's feed for 8 horses, compared with that of a year's fuel for a typical 8-16 oil tractor. (International Harvester Co.)

**The tractor and the horse-raising industry.** Because the tractor can relieve the horse of the drudgery of farm work, and do this work better, quicker, and cheaper, many have felt that it will have a tendency to injure the horse-breeding industry. On the contrary, there is evidence that the tractor is tending to stimulate the production of good horses. In many cases the combination of a tractor and brood mares for use on a farm has proved a practical and profitable one; the tractor relieves the mares of the heaviest farm work and makes possible the raising of better colts. Horses are money-makers for farmers; they are not a dead expense, as some tractor enthusiasts would have the public believe. There is no reason to suppose that the horse will not continue to be an important source of farm power.

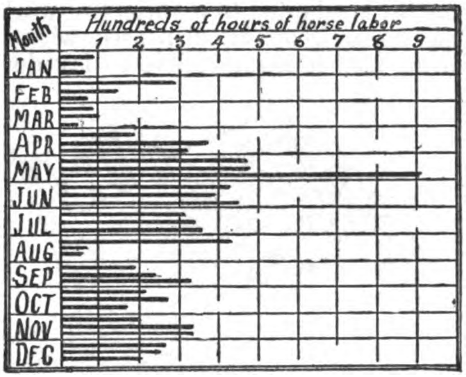



FIG. 91. How horse labor is distributed on a typical 200-acre corn belt farm. Though the use of the team may be limited by weather, etc., its upkeep continues with little or no reduction. (Farmers' Bulletin 719.)

The tractor has its advantages over the horse, and vice versa. It is not subject to death, and if it breaks down, it can be replaced piecemeal for a time. Yet it cannot reproduce itself as does the horse, nor convert the products of the farm, cheap roughage as well as grain, into power and fertility. The tractor has not yet reached the stage where it is as reliable as the horse.

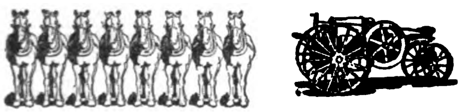



FIG. 92. 8,000 horse power hours can be delivered by 8 horses in one year; and by an 8-16 oil tractor in 100 days. On this basis alone, there is but one choice possible. (International Harvester Co.)

## Conditions that Make the Tractor Practical and Economical

The natural question of most men considering the purchase of a tractor is: When is it practical and economical to own one? There are, of course, a number of conditions, any one of which might justify the buying of a machine. But in most cases it is the need of more power that first raises the question of whether to buy or not to buy. Whether this need and several others will warrant investment in a tractor is a matter that the farmer must decide for himself.

The over-enthusiastic tractor salesman may advise selling off some of the horses on the farm to help pay for the tractor. This may not be the wise thing to do, especially if the tractor is being bought to furnish additional power. Displacing some of the horses is not necessarily essential to make the tractor practical and economical.

On most farms there are none too many horses in the first place, and the problem of extra power may be solved by buying a tractor. However, if the

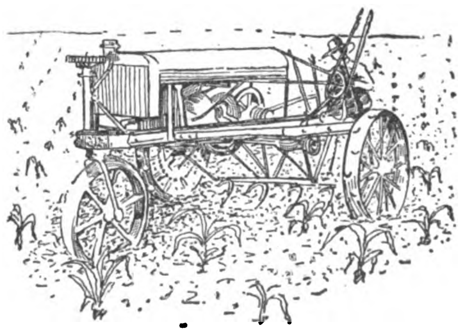


FIG. 93. A two-row tractor cultivator, capable of considerable speed variation and careful work along the crop rows.

tractor is adapted to a variety of work and will furnish cheaper power, some of the horses may be dispensed with. Conditions vary so widely on different farms that it is impossible to lay down any hard and fast rule on this point.

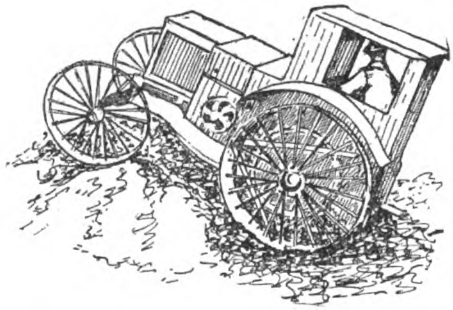


FIG. 94. Testing out a tractor to show its flexibility and resistance to unusual strain

**Labor shortage.** A shortage of labor might decide the question of the economy of buying a tractor, especially on the larger farms. If it were impossible to get sufficient help to handle the teams, one man and a tractor outfit could take the place of several men and teams, especially for such work as plowing, harrowing, and seeding; and instead of curtailing his farm operations, this arrangement might even enable the farmer to extend them. If the tractor should enable the farmer and his family to do as much work or more at less expense than when he relied upon hired help and horses entirely, it would be an economical investment for him.

**Size of farm.** For a tractor to be practical and economical, the farm must be of sufficient size to make it pay, and the lay of the land must be suitable for tractor use. Some farmers have found that they can make a tractor pay on 50 acres, but such cases are very few. Other tractor owners are of the opinion that a farm should be from 200 to 300 acres in extent to make power farming pay. The power requirement and many other conditions are so variable on different farms, that it would be impossible to say that one must have a certain, definite acreage under cultivation to make a tractor a profitable investment. If on any farm considerable additional power is needed, and if the tractor can be used on an average 100 days a year, or close to that, other conditions being favorable, it is pretty safe to say that the employment of the machine will prove both practical and economical.

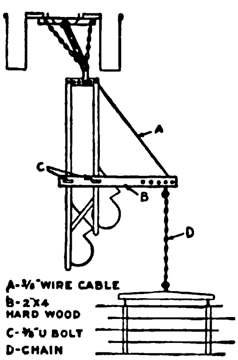



FIG. 95. Tractor hitch for 2 plows and a peg-tooth harrow

Many farmers have bought tractors more for the novelty of the thing than anything else, and the result has been failure. Buying a tractor means a big investment for the average man, and under no circumstances should he put his money into one unless he is sure that he can make it pay—and pay better than farming with horses alone.

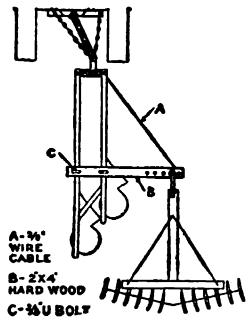



FIG. 96. For 2 plows and a disc harrow

A tractor is neither practical nor economical on a farm that is very hilly. Just how hilly a farm has to be to make it impractical can usually be found out quickly enough by trying the tractor out on the hills before the prospective purchaser places his order.

One of the principal objections to most tractors is that they do not have enough reserve power. They will pull their stipulated number of plows very satisfactorily on level ground, but when they come to a grade, the pull required is increased considerably, and the load may become so great as to make it necessary to pull out a plow or two. The power required in a tractor to do good work on hilly ground may be so great that it would not be practical to attempt to use one. Also, the hills may be so steep that it would be impossible to use a tractor owing to the difficulty of keeping it right side up. Another problem in this connection which tractor designers have not yet entirely solved is the proper type of wheel lug that will effectively prevent tractors from slipping sideways when used on hills, although the track-laying or caterpillar type of machine has proved very successful in this respect.

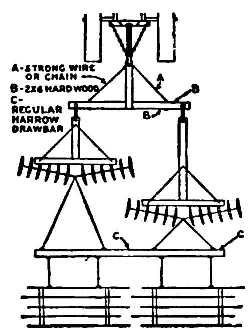



FIG. 97. For 2 disc and 2 peg-tooth harrows

**Type of farming.** The type of farming followed will determine to some extent whether or not one

would be justified in purchasing a tractor. As a general rule, where there is a considerable amount of plowing and other heavy work, to which a tractor is well adapted, and provided other conditions are favorable, it is safe to say that a tractor can be made an economical investment.

When the tractor first came into use to any noticeable extent, it was used almost entirely on the large grain ranches of the West. For the most part, the tractor (and this includes also the larger machines) is better suited to grain growing than any other type of farming. This is due principally to the fact that the types of tractors developed thus far, can, with but few exceptions, be easily adapted to practically all of the implements and machines needed in grain farming. Suitable engine-gang plows have been developed, and by means of hitches designed especially for the purpose, discs, drills, binders, etc., can be conveniently and satisfactorily used with a tractor. In fact, there are scarcely

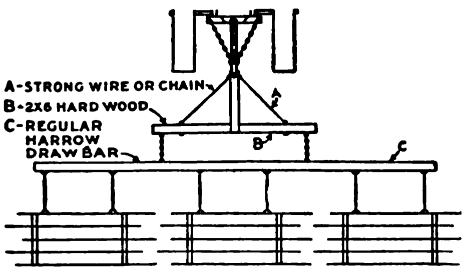


Fig. 98. Hitch for 3 peg-tooth harrows abreast

any operations connected with grain farming that the machine will not perform economically. The writer has even used it for hauling bundles from the shock to the thresher.

In the case of general farming, while there are more limitations in the use of the tractor than in grain farming, whether or not it would be economy for a farmer to own one would depend upon several conditions, principal of which, as pointed out above, is the possibility of using it for a variety of operations and keeping it busy a reasonable number of days each year.

One of the chief complaints that farmers operating small to medium-sized farms make, with respect to most designs of general-purpose tractors, is that they are not adapted to the cultivation of rowed crops. This is a serious disadvantage in a great many cases. In view of this limitation, the man who is considering the purchase of a tractor must have sufficient work aside from cultivating to make it profitable before he decides to invest. The tractor will, in many cases, under these conditions, relieve the teams of other work, so that they can be kept busy

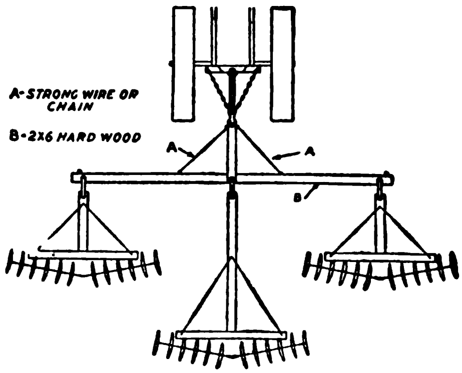


Fig. 99. Hitch for 3 disc harrows abreast

cultivating most of the time, at least when cultivation is necessary.

Though there are some makes of small tractor that are well adapted to cultivating, as well as plowing and other general farm work, there is still considerable doubt whether a tractor that gives maximum satisfaction for general work can be equally satisfactory for cultivating.

For a tractor to be practical and economical for fruit farming, the principal consideration is suitability of type. The machine must be built low, so that it can work fairly close to the trees, and pass under the branches without doing serious damage. The fact that the tractor can be used very satisfactorily with discs and other types of harrow makes it a very practical machine for orchard cultivation. If it is properly designed, it will work among the trees to much better advantage than teams.

**The owner and operators.** All other conditions being favorable, if the owner is not a fairly good hand with machinery, or if he is a poor manager, the tractor is quite apt not to be an economical investment for him.

With the right management, however, there is probably only a very small percentage of farms in this country, on which a tractor will not eventually be both practical and economical. While the present-day machines are profitable investments for a large number of farmers, there is needed a

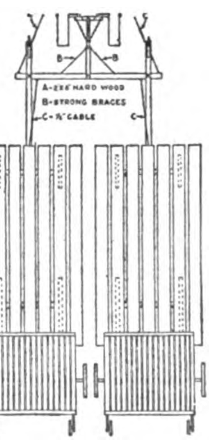


Fig. 100. Hitch for 2 hay loaders

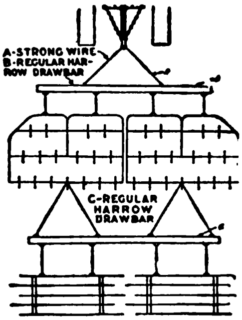



FIG. 101. Hitch for 2 spring-tooth and 2 peg-tooth harrows.

more suitable type as well as machines of better design and construction, before the economic value of the tractor to the great body of American farmers becomes established. But the limiting factor in any case is the "man behind." There are some men who, with the crudest and most poorly-built tractors on the market, have been highly successful in their power-farming operations, while others with the best machines obtainable have failed completely.

The farmer who is on the point of buying a tractor must remember that it is very different from the ordinary run of machines, and that to get even fairly good service out of it requires more intelligent care and operation than with any other piece of farm equipment. This is due to some extent to the fact that tractors are still in the early stages of development; as they are improved they will become more reliable and require less attention. Herein lies the reason why running a tractor is not a job for either a young boy or an inexperienced man. On many farms the owner himself or a grown son will handle the tractor, and if he has taken the pains to get the instruction necessary to handle it properly, he should have very little difficulty, provided the machine is a good one.

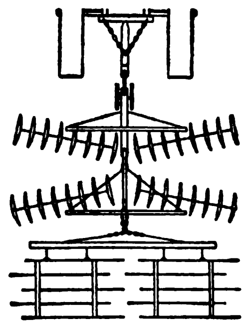


FIG. 102. A tandem hitch for disc and peg-tooth harrows.

On the other hand, a large number of farmers must depend on hired help to run their tractors, and in many cases this help will be extremely incompetent. Under such conditions, the purchase of a tractor may be of questionable advantage, for success with it is not to be had without efficient operation. An incompetent laborer may abuse a team and still get fairly good work out of it, but to abuse or neglect a tractor usually means disaster at the very start.

"Is the tractor a practical and economical investment for the tenant farmer?" is a question that is often asked. As a general thing it can be answered in pretty much the same way as for men who own their farms, as outlined in preceding paragraphs. If one is a good manager and not in that class of renters who change their location every year or so, and if other conditions, such as size of farm, type of farming, lay of land, financial standing, and so forth, are favorable, he will probably find a tractor a paying investment. But if it is necessary for the farm owner to consider very thoroughly every angle of the proposition before buying a tractor, it is doubly so for the renter.

## Putting the Tractor to Work

One of the questions that the farmer will probably ask before buying his tractor is, what kind of work will it do on my farm? As already pointed out, the extent to which it can be adapted to different operations will, of course, determine whether or not it will be a profitable investment. To give one who is thinking of buying a tractor an idea of what can be done with one, the following list of the more important uses to which tractors have already been put, should be helpful:

Plowing
Disking
Hauling harrows
Soil packing
Leveling land
Seeding
Planting and listing corn
Cultivating rowed crops
Hauling corn binders and pickers and silage harvesters
Filling silos
Husking and shredding and shelling corn
Grinding feed
Cutting fodder
Planting and digging potatoes
Mowing
Raking, tedding, loading, and hauling hay
Hoisting and baling hay
Hauling grain binders and headers
Combined harvesting and threshing
Hauling sheaves to thresher
Driving grain separator
Elevating grain
Hulling clover and alfalfa
Threshing beans
Road hauling
Grading, rolling, and dragging roads
Driving lime pulverizers and concrete mixers
Hauling lime spreaders and manure and straw spreaders
Harvesting beets
Clearing land

Sawing wood
Logging
Driving sawmills
Pulling fence posts
Stretching wire fence
Digging and filling ditches
Drilling wells
Pumping water
Moving buildings
Driving the farm powerhouse
Hauling spray rigs
Excavating for basements, pits, etc.
Digging nursery stock
Drilling holes for blasting.

Tractors have actually performed all the operations in the above list, and in a satisfactory manner as far as the mechanical operation itself is concerned. This does not mean, however, that each one was necessarily a success from an economical standpoint. Very often tractor owners, and especially the more irresponsible members of the farm force, will use the tractor for work that a team would do more easily and more economically.

In going over the list of uses, one tractor owner will decide that it is best to do certain operations with teams and others with the tractor, while another owner may decide differently. Just how far the individual owner can go in adapting his machine to a variety of work varies with conditions, and this is a problem that depends largely upon his own initiative for solution. This is not so important, however, as it is to know that the machine will perform practically and economically a few of the more important operations, such as plowing, disking, harrowing, seeding, packing, harvesting, threshing, etc.

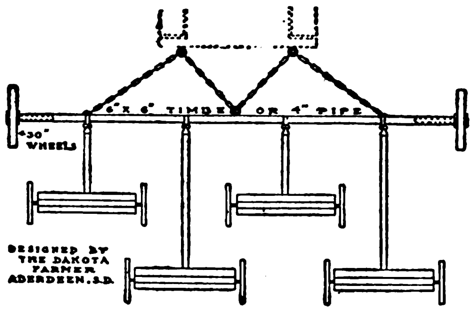


Fig. 103. A wheel and axle hitch for four seeders or other similar machines

**The tractor for plowing.** Plowing is by far the hardest of all farm work for horses, and it is the sort of drudgery for which most farmers need a tractor. In view of this, it is indeed fortunate that on the whole the tractor is better adapted to plowing than any other farm operation. It is also a fact that a good tractor outfit in the hands of a capable man will, almost without exception, do a much better job of plowing, and do it in less time and at less expense, than horses. This advantage of the tractor is realized by power farmers more when plowing for winter wheat or in the spring when the season is late and the work is rushed. It is entirely conservative to say that there is a fairly large percentage of farms in this country on which a tractor would be a profitable and economical investment if used for plowing alone.

To get the most out of his investment, however, a farmer should not be satisfied with maintaining a single-purpose machine, or one for which only a few uses can be found at the most. The tractor should be put to work at as many different tasks as it will perform quicker, easier, and cheaper than horses.

It is well before buying a tractor to make a study of the field and belt-power operations on one's farm that require power for their performance, and decide as far as possible how many of them can be done best with the tractor. With these different operations in mind, it will be easier to select a type and size of machine that will be suited to one's needs. As tractors become more generally used and as methods of using them are improved, the selection of the right machine will gradually become less difficult.

In view of the fact that farming with a tractor is very new, relatively speaking, the progress that many owners have already made in successfully putting their tractors to different kinds of work is remarkable. For example, a farmer in

Cherokee County, Iowa, says: "I have done everything on my farm with my tractor, except planting and cultivating corn, and the quality of work in each instance was better than that done with horses." A farmer in La Salle County, Illinois, uses his tractor for doing practically all kinds of field work (also excepting planting and cultivating corn), and he says that he can do it to far better advantage than he could with horses. His engine enables him to work faster, or to work on plowed ground with a disc and harrow, which is killing work for horses. This man has found by experience that there are some things a tractor is not capable of doing well. He considers it should be used only for doing those things which a horse should not be called upon to do anyway, that is, the heavy work on the farm.

Another Illinois farmer who has used a tractor 4 years, says: "The tractor is capable of doing a great deal more work than is commonly supposed. If it did nothing more than merely plow the ground, the great burden would be lifted from the horse, and would leave him much fresher and better able to do the remaining work of preparing the seedbed, planting, sowing, cultivating, and so on." Right along this line an Ohio power farmer says: "A farmer who does not own a tractor can scarcely have any idea of the many uses one can find for it. I would be completely lost now on a medium-sized farm without my engine."

### Field Uses for the Tractor

**Fitting and seeding.** Some farmers after plowing their land with the tractor use their teams for disking and putting it in shape for seeding or planting, while others use the tractor for both fitting the ground and seeding. If there is other more important work, or work that the tractor can do easier and better than teams, or if there is not a great amount of seeding to be done, and if the teams need exercise and the work is not too hard, it may be more desirable to use them for fitting and seeding. Again, if the land is very hilly or if the fields are so small and irregular in shape as to require frequent turning, it may be preferable to do the fitting and seeding and the plowing as well with teams. As a general thing, however, land that can be plowed more easily and economically with a tractor than with horses can usually be fitted and seeded more economically with the tractor. One of the principal objections at first to its use for this purpose was that it packed the plowed ground too much. It is true that it does this if the soil is too wet; but if the soil is not too wet to be worked, in 99 cases out of 100, no harm will result from the packing effect of the tractor wheels, and in a great many instances it proves actually beneficial. Even under unfavorable conditions, that is, in soil that is too wet, some have found that tractors produce no more harmful effects than horses.

An undoubted advantage which the tractor has over teams is its ability to cover more ground in the same length of time than the same amount of power in the shape of horseflesh; and if it can be used satisfactorily on plowed ground, without too great a power loss, its performance for fitting and seeding

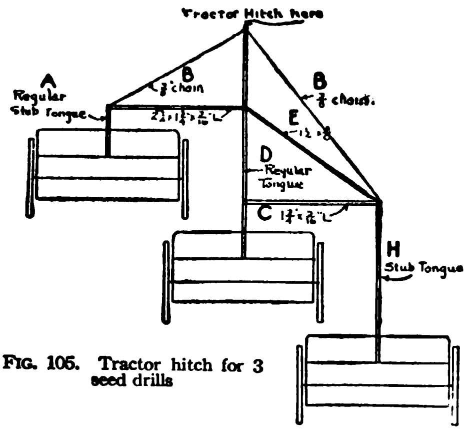



FIG. 105. Tractor hitch for 3 seed drills

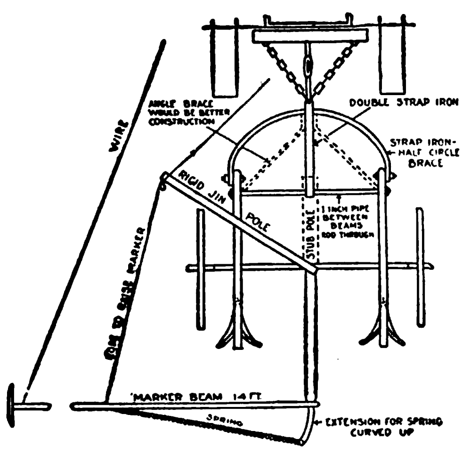



FIG. 104. Tractor hitch for a 2-row lister

operations should at least compare very favorably with horses.

For fitting and seeding with a tractor, most owners aim to hitch two or more implements in combination behind it. On the larger farms where the fields are 20 to 30 acres in extent or larger, special hitches are used for spreading the implements out abreast, principally discs and drills. In this way a large acreage may be covered in a short time and 2 or 3 operations combined in 1.

On the small to medium-sized farms, where the smaller tractors are used in small fields, a common practice is to hitch a disc and smoothing harrow, or a disc, drill, and smoothing harrow or packer in tandem behind the tractor and combine the fitting and seeding in one operation. Another excellent method of preparing plowed ground for winter wheat, or, in fact, for any crop, is to follow the plow at least every half-day with a disc harrow and soil packer hitched in tandem behind the tractor. Because of the looseness of the soil this would be extremely difficult work for horses, but the tractor usually makes easy work of it.

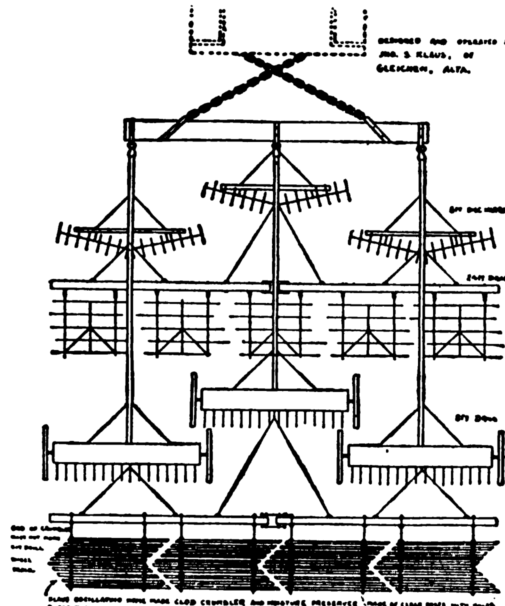


FIG. 106. Combination hitch for 3 double disc and 5 peg-tooth harrows, three seeders and a plank drag or soil crumbler

If there is sufficient power in the tractor, it is a good thing in seeding to use the disc just ahead of the drill. It not only gives the ground an extra disking, but the seed is placed in freshly stirred soil where germinating conditions are more favorable to a good start.

One spring the writer used a tractor outfit for fitting and seeding corn stubble to oats. Directly behind the tractor, and fastened to it by means of cables, was hitched a large I-beam, which dragged along, crushed the corn stumps and leveled the ground. Behind this and hitched to the tractor was a double-throw disc harrow, and behind the disc came the drill, the tongue lying on the frame of the disc. The disc was weighted down somewhat, and as the soil was just right as to moisture, the disc prepared a fairly good seedbed. With the drill following the disc closely, the oats were put in under favorable conditions. As the teams on the farm needed exercise, they were put to work harrowing and cross-harrowing after seeding.

Many tractor owners in using an outfit of this kind build a platform on the disc to carry sacks of grain sufficient for half a day's run. If the construction and arrangement of the disc and drill will permit, a "gang-plank" may be built from the disc platform to the drill, so that the grain-box on the drill may be filled without coming to a stop. This saves considerable time in the course of a day, as otherwise it is not necessary to stop often, providing the tractor gives no trouble.

On the other hand, such an arrangement requires 2 men with the outfit, which often may be undesirable. However, to get the best results the outfit should be attended by 2 men. This allows the tractor operator to attend to guiding the outfit and watching the engine, and the other man to look after the implements handled. Herein lies one of the serious limitations of most tractors, which is, that, in order to drive them, the operator is compelled to sit on the tractor instead of on the implement that is being hauled. While this works out very well in plowing, in other kinds of work, more especially seeding and harvesting, it is a big advantage for the operator to be back where he can watch the entire outfit. Perhaps an even greater objection than this is the fact that in many cases 2 men are needed where, if teams were used, only 1 would be required. In this connection, however, it must be taken into consideration that the tractor will work much faster, as a rule, than horses, as well as a greater number of hours a day. On this account it may be more economical to use the tractor, even though an extra man is required.

**Haying.** The tractor is coming more and more into use for haying operations. No tractor as yet, however, is a complete success in hauling mowers, although 1 or 2 make fairly creditable work of it. These machines are so arranged that the operator can sit on the mower seat, where he guides and controls the tractor and handles the mower from the same position. Some owners have hitched

two or more mowers behind a tractor by means of offset tongues. Such an arrangement is usually more expensive than mowing with teams, for, besides requiring a man on each mower, an extra man is needed to operate the tractor.

Whether or not it would be more economical to use the tractor for mowing would depend on conditions; ordinarily it would not. Mowing is comparatively light work, and, even in hot weather, the teams can rush it along almost as fast as the tractor. Besides, there is no question but that the horse is a more flexible motor for this work than is the tractor. The same thing holds true in the tedding and raking operations; for the most part teams will perform them best.

On land that is not too hilly the tractor will usually be found better suited to hauling hay wagons and loader than teams. A farmer in Wood County, Ohio, finds this very practical work for his tractor. The engine having more power than his team enables him to put on a larger load. It also travels much faster than horses, which is an advantage when hauling the load to the barn, or the empty wagon to the field. This man says that the men who do the loading find they can work with greater ease behind the tractor, as it produces a steadier pull than horses.

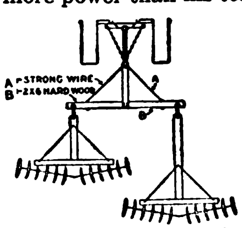



FIG. 107. A simple hitch for 2 disc harrows

**Grain harvesting.** Aside from plowing, and possibly preparing the seedbed, there is probably no more important operation on the farm for a tractor than harvesting grain. One of the serious objections in the past to its use for this purpose has been that 2 men were needed, while 1 could handle a 4-horse team and a binder. Some of the larger tractors have been used to haul 2 or 3, and even as high as 6 or 8, binders, by means of offset tongues, but a man or boy was needed on each binder. This objection is gradually disappearing with the introduction of new designs of tractors and improved attachments on older designs that permit the operator to ride on and control his engine from the binder seat.

Wherever it is practical to use the tractor for harvesting, it will usually be found superior to teams, principally because of its ability to work faster. The writer has found that it is not usually necessary to begin harvesting so early with a tractor as with horses. One can wait until the grain has reached the right stage of maturity to be harvested, and then keep his tractor and binder at work, if need be, 14 to 16 hours a day, or from dew to dew. Hot weather is not a hindrance to the tractor, the only stops necessary, if the outfit is in good condition, being for meals, to oil the machinery occasionally, fill the twine boxes, and make any minor adjustments, etc., when needed. In this way a large acreage of grain may be cut in a short time, if everything goes well.

However, for harvesting, as well as other farm operations, with a tractor the element of chance is a bigger factor than with teams. If the owner is not careful to see that the machine is in first-class condition before harvesting starts, and that it is kept in good order all the time it is working, a breakage or other mishap may occur that will seriously delay the work, even more so than would teams. Also because the tractor will work faster than horses, it will wear out the binder much faster. Where tractors can be speeded up to 3 or 4 miles an hour, a great many owners have attempted to haul binders at that speed. To say the least, this is almost without exception impracticable, and the delays caused by breakages usually offset the time saved. A speed of 2½ miles an hour is quite fast enough for a binder.

**Cultivating.** One of the most serious limitations of most tractors, when it comes to putting them to work, is that they are not adapted to the cultivation of rowed crops. There are one or two makes, which come in the class of general-purpose tractors, that are fairly well suited for this purpose, but the rest are not. There have also been designed a few machines especially for cultivating, and

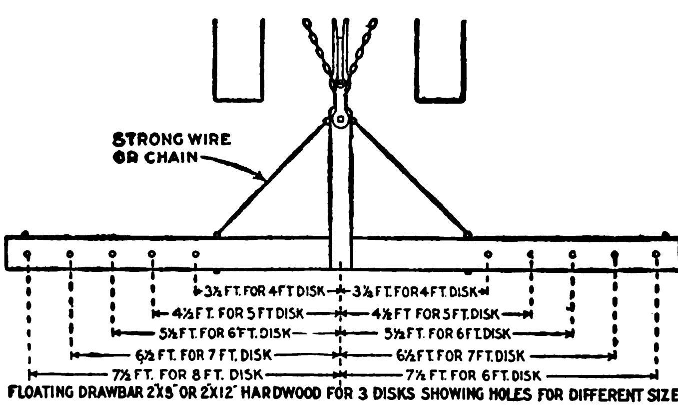



FIG. 108. General purpose hitch and drawbar for tractor work. (This diagram, Fig. 95 and all between, courtesy of the International Harvester Co.)

success in this direction is very promising. These same machines without a great deal of change can be used, also, for planting and listing corn, planting potatoes, and other light work.

**Belt work.** There is quite a variety of belt work on the farm to which the tractor can be put. In general, this is easy as compared with some of the field operations, provided the tractor is well adapted for belt work. The table given previously will suggest quite a variety of tasks.

Speaking with reference to belt work on the farm, a tractor expert of the United States Department of Agriculture recently said: "Belt work is the largest item which can be included under one head; this represents, on an average, about 50 per cent of the work which the tractor generally does on farms. This, of course, includes many different kinds of work, but usually there are only two limiting factors involved: one is the amount of power available for the heavier operations such as cutting silage or running a separator; the other is the question of economy in doing the lighter jobs. Aside from these the nature of the belt work is immaterial; the tractor will take care of it."

## Tractor Management

**The "man behind" the tractor.** Fundamental to the success of the farm tractor as a practical and economical investment is, as stated above, the human element—the "man behind." No matter how favorable conditions may be to its profitable use on any particular farm, unless the owner is a good manager, and operates and cares for his tractor properly, he must not expect to make his power-farming operations a success. Briefly, good management is even more essential when using a tractor than when farming with horses only, largely because a tractor will not stand abuse and bad management and still do good work, as well as teams.

While not heard so often now as in the past, a favorite claim of tractor salesmen has been that "anybody can run it." This has been the means of misleading a great many tractor buyers, making them expect more service from their machines than they could possibly deliver, and also giving them the impression that it was not necessary to study their operation very much to be successful. The conclusions reached on this point by the United States Department of Agriculture, after extensive tractor investigations by one of its experts, are as follows:

"It would appear that some manufacturers have felt that it was a discredit to their tractor to admit that a man need spend any time in learning to operate and care for it. Extravagant claims that 'anybody can run it' have resulted in many farmers feeling that it was an admission of a lack of even ordinary mechanical ability on their part to require instruction in the operation of a tractor or to ask for advice concerning it. This fact has been largely responsible for the need of so much expert service being required after machines have been in operation a short time.

"Actual experience in thousands of cases has shown so conclusively that running a tractor is not a job for either a boy or inexperienced man that it should be unnecessary at this stage of tractor development to have to take time to contradict the old statement that 'any boy can run it.' Every experienced tractor manufacturer knows better, and the new ones who still make such claims not only show their lack of experience, but are paving the way for service troubles at a later date by misleading the purchaser and preventing him from taking the trouble to inform himself fully regarding the operation of the outfit.

"The tractor is strictly a business proposition with the farmer. He cannot afford to risk delays with his work at critical seasons when a small amount of time and money spent in learning how to run the outfit will give a strong guarantee that such delays will be avoided."

**Getting results.** Good tractor management involves getting as much work as possible out of the machine to make it a profitable investment. As already pointed out, however, this does not mean using the tractor where it would be better to use teams, just to get work out of it. On the average, tractor owners do not get much more than about 50 days' service a year from their machines. In some cases the tractor may be profitable even at this rate; but, as a rule, it is more apt to pay if there can be found 100 or more days' work a year for it.

Getting the most work out of the small or medium-sized tractor on a medium-sized farm means using it for as many different kinds of work as is found practical. And to be more practical and economical than horses for any particular operation, it must be able

to perform that operation quicker, easier, and cheaper.

Few tractor owners have used their machines for as great a variety of work as the tractor is capable of performing profitably. The principal reason for this is that the hitching to a tractor of implements designed to be used with horses is quite a problem. For the most part it has been left to the farmer to be solved as best he could solve it, little having been done during the early years of tractor building, by manufacturers, to develop suitable attachments for connecting various farm implements to the tractor.

It requires no little initiative and ingenuity on the part of the tractor operator to devise convenient hitches that will satisfactorily meet his particular needs, and with which he may operate his tractor outfit without bringing about unusual strains or unnecessary wear and tear on any of the equipment. Two fundamental aims to keep in mind when hitching implements to a tractor are: (1) A quick, easy method of connecting and disconnecting the tractor with and from the rest of the outfit; and (2) the greatest possible flexibility of operation, especially in turning. If the operator takes the pains to study this problem thoroughly and watch his outfit closely when at work, to discover ways and means of improving the hitching, he should not have much difficulty in getting satisfactory operation.

**Tractor must be properly cared for.** Good tractor management includes proper care of the tractor. The right kind of care is essential not only to keeping it in the best working condition at all times, and consequently avoiding expensive delays on account of breakdowns or neglect, but also to prolonging the life of the machine. And in this connection it cannot be too strongly impressed upon operators that they cannot expect to give the tractor the right care without a thorough study of the instruction book and following the manufacturer's recommendations. Many tractors have proved utter failures for no other reason than that they did not receive intelligent care.

On farms where the fields are badly cut up or irregular in shape, as is the case in so many instances, it is usually advisable to square them up wherever possible, even to the moving of fences, in order to get more satisfactory results in the use of a tractor. It is not only easier to handle a tractor in regular-shaped fields on account of the fact that it is not as flexible as a team, but it will do better work and work closer to the corners. Long, narrow fields are the most suitable for tractor operation, as a minimum of turning is required. It will no doubt be found that where a tractor will prove a considerably more economical source of power for the bulk of the work than horses, it would be profitable to relay out all or part of the fields on the farm to facilitate tractor work. Some tractor owners have done this and found it paid. As a rule, however, this change should be a gradual process and the result of careful study and planning.

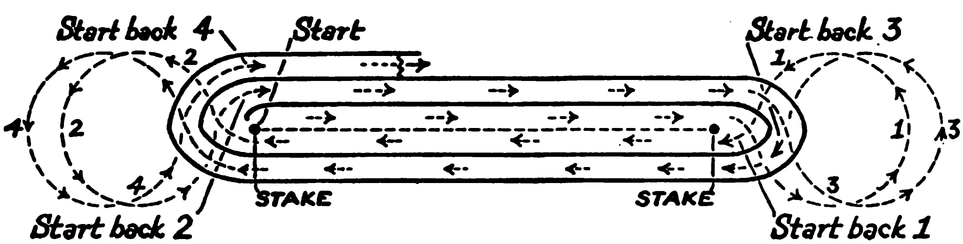



FIG. 109. How to begin a method of tractor plowing that does away with dead- and back-furrows. The arrows show the course of the machine and the figures the order in which the reverse loops are made. From here on the ends can be plowed around without a change of direction. (International Harvester Co.)

## The Size and Type of Tractor to Buy

The right size of tractor to buy is naturally a difficult matter for the man who is about to buy his first. The smallest practical size on even the smallest farm is the 2-plow machine, and, according to an investigation conducted by the United States Department of Agriculture among 200 Illinois tractor owners, the minimum size of farm, in the opinion of these men, on which this size of tractor can be used profitably, is 140 acres. This does not necessarily mean that no farmer with less than this acreage should buy a tractor, for a great many farmers can and have made this size pay on even as low as 100 acres. But in considering the purchase of a machine for a farm of less than 140 to 150 acres, a great deal of thought

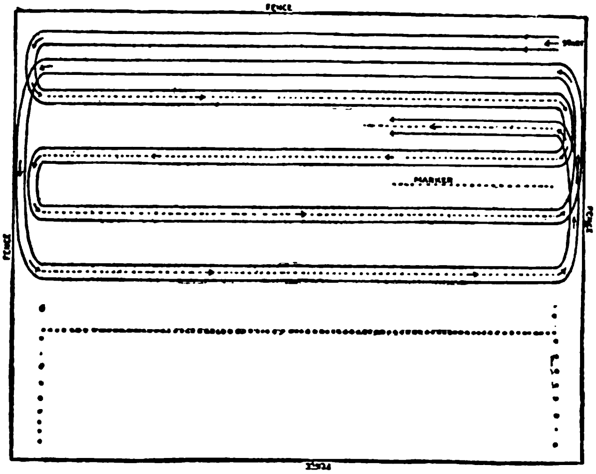


FIG. 110. Field laid out for listing corn with a tractor so as to avoid short turns. The dotted line shows course of the marker. (International Harvester Co.)

and study should be given it in order to determine whether or not it would be a profitable investment.

Size. In making the purchase it is necessary to buy a tractor of the proper size in order that it may be most practical and economical. In the first place, one should get a machine that has plenty of power for all his work. A tractor of insufficient power to do the work required of it, will naturally prove unsatisfactory. Then again if one buys a machine with more power than he has any need of, it may be too cumbersome and expensive to operate for a variety of tasks on the farm, for both light and heavy work.

In the Government investigation referred to, an important point relating to the best size of tractor, as brought out by the experience of the Illinois tractor owners, was that for farms having 200 acres or less of crops, a 3-plow tractor is considered the most desirable, while a 4-plow machine would probably be better on this size of farm than a 2-plow outfit. On farms of more than 200 acres and up to 300 acres of crops, a 4-plow tractor is generally believed to be the most suitable, while either a 3- or a 2-plow machine would be better than one pulling more than 4 plows. On farms of from 300 to 750 acres the 4-plow tractor was still favored.

**Three- and four-plow tractors.** Tractor manufacturers building a variety of sizes, as well as investigators who have made a careful study of this phase of the tractor question, are agreed that the 3- and 4-plow machine is by far the most economical size. Probably on most farms this size will give the best all-'round satisfaction. On the larger farms, where more power is needed, it is usually better to have two 3-plow machines than one 6. In a great many cases, farmers who have purchased 6- and 8-plow outfits have stated that it would have been better economy to buy two smaller outfits rather than the one large one. The reason for this is that very often, especially for the lighter work of harrowing, seeding, etc., one smaller machine would do the work just as well as the large one, and the expense of operation would be less. Another reason is that, if in plowing or work where both were needed, one should meet with an accident causing a delay, the other would keep on working and the delay would consequently be less costly.

Recently a personal investigation was conducted among several tractor owners, owning different sizes of machines, to ascertain what it costs to do farm work with the different sizes. A careful analysis of the costs, including depreciation, repairs, and interest on the original investment, brought out the interesting fact that the cost of doing work with the 3- or 4-plow tractor was invariably less than with either a 2-plow machine or the larger sizes.

Information on this subject is sufficient to justify a definite statement that a 3- or 4-plow tractor will best meet the tractor requirements of the average farm. With this size one can plow much faster than with horses; besides he can handle 3 or 4 plows, whereas one man is needed with each 2 plows when horses are used. This size of machine has enough power to operate practically all belt-driven machines on the average farm, even a small-sized thresher or silage cutter. Also, it is not so large as to be too expensive for doing many kinds of work that do not require very much power.

The size of a farm does not, or should not, determine the best size of tractor to buy. One should outline carefully the different kinds of work for which he proposes to use his tractor, and then select a machine that will have plenty of power to do the most difficult tasks required of it. In this connection, if it is desired to have a tractor merely to furnish additional power during times when the work is rushed, in cases where there is

only a small need of belt work and where most of the field work is done with teams, it is possible that a 2-plow tractor would be the most logical one to buy. Some have found this to be the case. A particular advantage of this size is that a smaller investment is required. This size is also recommended as a good one to buy at first, especially in cases of minimum power requirements, in order to gain experience in the handling and care of tractors.

The Department of Agriculture and other authorities are pretty much agreed that, generally speaking, it is better to make the mistake of buying too large a tractor than one that does not have power enough. This does not mean, however, that the purchase of the largest sizes is recommended, but it does refer to the rather too common practice of buying a 2-plow tractor to do the work that really requires a 3- or 4-plow machine.

**Types of tractors.** Tractors are variously classified, but the classifications of the greatest interest to farmers are based on (1) type of traction members; (2) number of wheels; and (3) motor.

**Traction members.** As to these there are two general types—the round-wheel and the track-laying or caterpillar. Until recently it had been generally considered that the track-laying type was more of a special-purpose machine, for use where it was necessary to travel on soft ground or to negotiate very wet or very sandy fields. This machine, however, is gradually coming more and more into favor as a machine for all conditions. In fact, at present it bids fair to become a strong competitor of the round-wheel type.

One of the principal disadvantages of the track-laying machine is the short life of the track, necessitating rather expensive replacements, and another is the much higher cost of this type, due to the expensive track construction and mechanism. One company claims to have solved the problem of excessive wear on the track; but with most machines of this type the track, especially under some conditions, is apt to be one of the main weaknesses. On the other hand, a particular advantage of this type is the fact that a larger percentage of the power of the motor is available at the drawbar than in a round-wheel tractor, because the slippage of the traction members in most cases is practically negligible. Especially is this true where the surface of the ground is inclined to be slippery, and also in plowed ground.

**Number of wheels.** As to this, the 4-wheel type is the most popular, the 2-wheel next, and the 3-wheel third and fast losing favor. The 2-wheel type is confined almost entirely to one or two makes. It is well adapted for use with quite a variety of farm implements, especially planters, cultivators, binders, etc., and has the particular advantage that it permits the operator to drive and control the tractor from the seat of the implement being hauled. Its particular disadvantage is the inconvenience of disconnecting it from one implement and hitching it to another.

All things considered, the 4-wheel type is perhaps better adapted than the others to plowing and other heavy work. Its principal limitations, in most makes, are that the operator is compelled to operate the tractor from the tractor itself, instead of from the implement it drives, and that the machine is not well adapted to cultivating.

**The motor.** As to the motor in a tractor, many manufacturers, and owners too, still favor the 1-cylinder and 2-cylinder types, although there is a decided tendency toward the use of the 4-cylinder motor.

**The type to buy.** In buying a tractor, price should be a secondary consideration; for it pays best in the end to add $200 or $300 or even more, and get a durable, reliable machine. It should not only be well designed and constructed with the best materials, but it should embody such features as ball and roller bearings, cut-steel gears enclosed and running in oil, and enclosed working parts; all these will add several years to the life of the machine. The ultimate type of farm tractor has not yet arrived, and it may be several years before it does; but, under favorable conditions and in the hands of a good manager, any one of several makes now on the market is practical and can be made a paying investment.

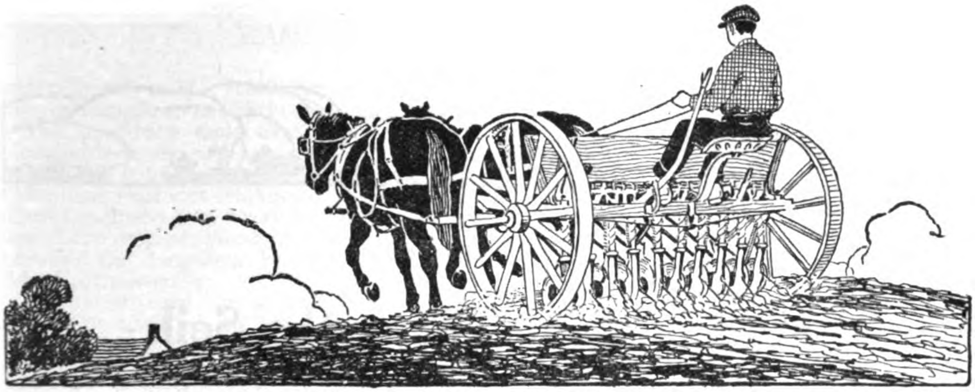


FIG. 111. Present day farm implements make the larger planting and better care of crops easier than they have ever been. All the world wants more food; shall it look to the farmer for it in vain?

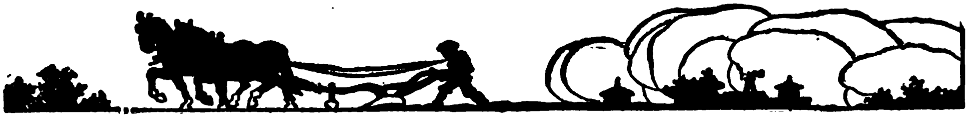
# FARM KNOWLEDGE

## PART II

# Farm Implements

WHEN the aim and problem of man's existence consisted merely of the providing of his immediate family with food, shelter, clothing, and protection, there was no need for him to raise more crops or handle more food animals than he and his sons could look after with the help of whatever crude implements their stage of development happened to afford them. Modern illustrations of these prehistoric conditions are to be found in the undeveloped sections of the Canal Zone, of Africa, of South America and other unexplored or, at least, unmodernized regions. However, as men began to take up special lines of work, some found themselves confronted by the task of providing their industrially or artistically or commercially inclined neighbors with the products of the soil—that is, they became farmers. And the increased demands upon their industry gradually made it imperative that they multiply their productive ability. They had to have implements with which to handle larger fields, cultivate larger crops, harvest and dispose of larger yields. This, in briefest outline, is the history of the development of farm implements and machines; to what length it has been carried is suggested in the seven chapters forming this part of this volume.

It is easy to overlook the important part played by the manufacturers of farm machines in educating farmers to their use. Of course it has been good business policy, but it has been more than that; for the intelligent, effective use of labor-saving devices is one means of increasing the total yield of staple crops, and never has the need of increased production been as obvious and serious as it has become of late years. However, there are principles, comparisons, analyses, and descriptions that cannot find a place even in the excellent catalogs and instruction books issued by those who are best informed about the various implements; and which are none the less invaluable aids to a correct understanding of the place and purpose of the tools, and their successful operation. It is from this standpoint that the various tillage, seeding, harvesting, spraying, and other implements described hereafter, are treated. Other discussions of implements may be found in Vol. II, in the chapters dealing with the handling of the soil, the raising of special crops, etc.—EDITOR.



## CHAPTER 7

# Machines for Tilling the Soil

*By* F. H. DEMAREE, *Farm Advisor of Grundy County, Illinois; who was born on a farm in Indiana. He graduated from Purdue University after having specialized in crop production and plant breeding, then went to the University of Missouri as assistant in crop production, becoming Assistant Professor within 3 years. He then became Agronomist and Advertising Manager for the J. I. Case Plow Works, in which capacity he became familiar with practically all types of implements used in nearly all parts of the country. As part of this work, he started a demonstration farm on which were tested all sorts of new machines and their parts. After 2 years at this, fearing that he might be "getting too far away from the farm," he spent a year with the Crop Improvement Committee of the National Council of Grain Exchanges, and then, in 1915, took his present position. His work has therefore brought him in touch with all kinds of farm implements, most of which he has operated either on his home farm or, in demonstrations, on other farms.*—EDITOR.

## Plows

WHEN man began to scratch the surface of the soil with a crooked stick, agriculture was born. Since that time the art of farming has been very slowly evolved to its present stage. Ages ago a type of wooden plow was designed, which was a great improvement over the crooked stick; but which was very cumbersome and easily worn out, to say the least. The past 75 years have seen the invention and development of the steel plow to its present high state of perfection and efficiency. This implement, more than any other, has made possible present-day farming methods.

**Plow classifications.** All plows may be divided in 2 general classes: those which turn the soil with a moldboard, and those which turn it with a revolving disk. Of these, the moldboard type is the original, and it still continues to find favor with the vast majority of farmers.

**Moldboard plows.** All plows of the moldboard type may be subdivided according to the shape or turn of the moldboard. This subdivision has been made necessary by the fact that soils differ widely as to the ease and manner with which they may be properly plowed. This difference may be further increased by the manner in which the land is farmed or by the type of crop grown on the land preceding the plowing. For instance, a heavy soil which has been growing a grass crop that has produced a sod cannot be properly turned with a short-turn or stubble moldboard.

On ordinary plowland the furrow slices should be turned over and, to a certain extent, lap one another. All weeds or trash will then be buried, and the ground can be easily leveled. On ordinary grass-sod land the furrow slice should be made with a medium lap, not flat, but far from on edge. Native sods which have never been broken should be turned down as flat as possible, owing to the fact that the sod is so stiff that it is exceedingly hard to work up a seedbed, and, unless the furrow slice is turned down flat, the sod will not rot, air spaces will be left underneath, and a poor crop will be apt to result. This is the only exception where a flat furrow slice is desirable. Ordinarily, a flat furrow slice beats down easily with heavy rains, and is, consequently, hard to get in planting shape. A furrow slice on edge is also hard to work down, and it leaves trash and sod on top of the ground.

In order to secure good plowing results, therefore, three distinct types of moldboard are made: sod, long-turn boards, sometimes called "sod" and "stubble boards," and short-turned boards, often called "stubble boards."

The typical sod moldboard is long and narrow, and it has very little turn. It is designed to plow native sods and thick grass

**sods of heavy soils.** It will turn a flat furrow slice or edge it up as lightly as desired.

The long-turn moldboard is designed to plow lighter sods, such as clover and timothy, and it will turn over even furrows, lapping them nicely without crinkling. It is also used almost exclusively in heavy clay soils, regardless of the crop previously grown on the land, because the long-turn board is lighter in draft on these soils.

The short-turn, or stubble, moldboard, should be used on all loose, easily plowed lands. This type of moldboard elevates the soil quickly, turning it almost completely over. It is very efficient in burying trash and in exposing the upturned soil to the sun. It will not do a good job of plowing in sod, and should not be used there if it can be avoided. When so used, the land looks very rough, with the furrow slices badly crinkled, and much sod exposed, which will certainly be dragged out on top when the land is being fitted for a crop.

**Scouring.** The different styles of moldboards mentioned above find their great adaptability to the kinds of work described, not only because good work is done, but because, in the main, the moldboards scour best under those conditions.

When a plow is scouring properly, the soil slips over the moldboard without any indication of sticking, leaving the moldboard bright and shiny, and giving a soil polish to the underside of the furrow slice as it slips from the plow. A plow will scour easily in a heavy clay soil, the particles of such a soil hang together with little tendency to stick to the plow. The long-turn board does good work with less draft in such soils. A sandy or gravelly soil, also, scours easily under most conditions; the grit keeps the finer portions of the soil from sticking. These soils are generally so loose in texture that a short-turn board will do the best job of turning. Loose loamy types of soil give the most difficulty in plowing; the soil particles do not hang together, and they stick to the moldboard badly. This is especially true when the soil is wet. To overcome this, short-turn boards are used. It has also led to the use of specially hardened, highly polished steel, so that the least friction with the soil is produced.

Under particularly aggravating conditions, a slatted or rod type moldboard may be used. In these, the upper end instead of being solid, is cut into narrow strips, or slats, which, owing to the lessened surface, do not cause as much friction as a solid board. In very sticky lands, this type of board should scour where others fail.

**The walking plow.** The walking plow is universal, one or more being found on practically every farm. It must be depended on exclusively where the land is very hilly or contains stumps and stones which will not allow the use of a riding plow. Under all

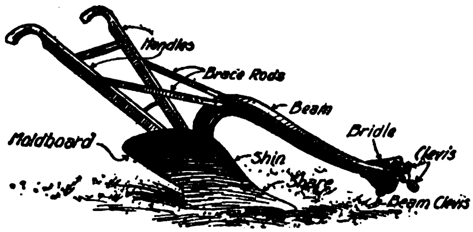



FIG. 112. A modern, general-purpose moldboard plow

other conditions, it has been practically discarded in favor of the lever riding plows, except for garden work and the plowing of smaller lands, ends, and corners. Walking plows are made with either a right- or a left-turn board. The right-turn boards are more favored in most localities.

In selecting a good walking plow, there are two important things to consider: the frog brace and the beam. The best brace is made of steel, thoroughly supports the moldboard, landside, and share, or lathe. If this is poor, the plow is short lived. Originally, all walking plows were made with wooden beams. A wooden beam can still be secured, but the use of steel beams has increased steadily. The great disadvantage of the steel beam lies in the fact that it can be sprung. When the set of the beam is sprung out of line in any manner, the plow never works properly; it should be sent back to the factory for adjustment. There is, of course, no danger in springing a wooden beam, but there is more or less danger of breakage, so that these two features about offset one another.

**How constructed.** The base of, or key to, the construction of the walking plow is the frog. This is a heavy steel or malleable iron piece curved on one side, to fit the shape of the share and moldboard, and perpendicular on the other, for the attachment of the landside. The beam is securely bolted to the underside of the frog. The share slips over the lower end of the frog and attaches to both the curved side and the square side, thus forming a very secure union. The moldboard proper is then fitted against the upper edge of the share and bolted to the frog at the lower end.

**The care and adjustment of plows.** But few adjustments are called for in the case of a walking plow, the main ones being at the clevis where the hitch may be raised or lowered to regulate the depth of the furrow, or moved from one side to the other to regulate the width of the furrow slice.

Good care of a plow always pays. Do not leave it in the ground at night, even though the job is not finished. Wipe off the moldboard and share so they will hold their polish. Grease these parts thoroughly during rainy spells and before putting the plow away for winter. A little such attention often saves hours of hard labor in scouring a rusty plow.

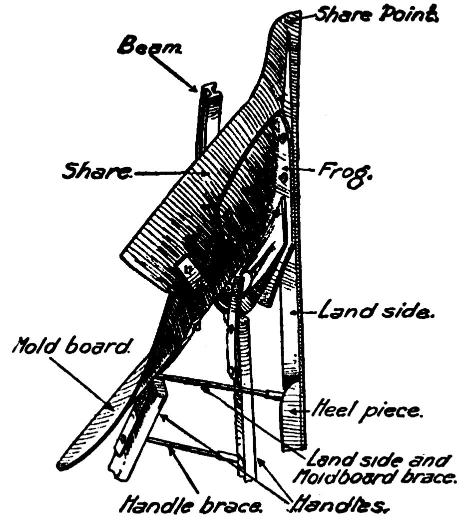



FIG. 113. Bottom view of moldboard plow indicating the essential working parts

One handle is attached to the moldboard, helping to brace the upper end of it and the other is usually attached to the beam high enough to avoid dragging against the furrow bank. The handles are separated and held in a position by brace rods, 1 being near the lower end and, generally, 2 at the upper end. The upper brace rods are the longer, thus giving the desired spread to the handles. Running between the landside and moldboard, there is also an additional brace rod, which supports both parts when the pressure of turning earth is thrown upon them.

**Small moldboard plows.** In the North, there is some demand for small plows for either 1 or 2 horses, for garden or small farm use. Many of such plows, however, are sold in the South and Southwest also.

Most manufacturers put these plows out in two types or series, the black-land type and the sandy- or loose-soil type. In both kinds the sizes range from a 5-inch to a 14-inch bottom. The black-land plow has a long, tapering moldboard with a narrow pointed share. The share is given plenty of suction to hold the plow in the ground. The sandy-land plow has a broader moldboard with a considerably quicker turn than is used on the black-land plows.

Although a sandy soil will generally scour easily, it is not advisable to use the long-turn moldboard, for this soil does not possess sufficient body to carry the length of the board and then turn into a clean furrow slice. It is apt to edge over leaving much trash exposed. A short-turn board, on the other hand, does good work under such conditions.

**Middle breaker.** The middle breaker or "middle buster" as it is commonly called, is a double-moldboard plow which throws a furrow slice to both sides, leaving a trench. Middle busters are practically always made in walking types only, as listers use the same construction, and middle-buster bottoms can be attached to riding plows. Middle breakers are used principally in the southwestern and western portions of our Great Plains states, where it is necessary to leave land in ridges and furrows in order to conserve moisture and avoid damage from the wind.

In construction, the middle breaker is very similar to the walking plow. The share is made in one piece, and in appearance looks like two ordinary plowshares, one a right- and one a left-turn, welded together and forming a sharp ridge down the centre. The moldboard wings, also, form the same sharp ridge where they join, and, when both share and moldboards are attached to the frog, this ridge is continuous. The moldboard wings may be in one solid piece, like the share, or in two separate pieces, so as to be easily removable.

**Sulky plows.** The original sulky plow was hardly more than a walking plow on wheels. It had no frame, and was controlled by hand levers. A large number of frameless lever-lift sulkies is still being manufactured every year, and these plows find a great deal of favor in practically all sections of the country. They are usually lighter in weight and less expensive than other kinds, and, being short-coupled, can be used to make a square turn when it is desired to plow ground in lands, going around the field to turn either in or out.

A more recent development of the sulky plow is the supporting of the beam in a frame, while the operation of the plow in raising and lowering it is controlled by a foot-lever lift. In plowing position, the plow is locked in the ground. This type of sulky requires more adjustment and is heavier and more expensive than the frameless type. On the other hand, it is much easier to operate and, generally, does better work, owing to the fact that the plow is held in the ground at a more uniform depth.

**Construction of frame riding plows.** The riding plow has all the main features of the walking plow, in so far as the plow bottom and beam are concerned. In addition, the beam is set in a frame supported by 3 wheels: the land wheel, front furrow wheel, and rear furrow wheel. The two furrow wheels are joined and held in line by a long connecting rod that extends from the upper end of the rear furrow wheelpost to the upper end of the front furrow wheelpost. This rod is adjustable at the rear connection, so that it may be shortened or lengthened, thus changing the angle of the furrow wheels.

Furrow wheelposts extend upward through the back portion of the frame and the front corner of the frame to which the axles are

attached. In front, a ratchet and lever are attached to the front furrow wheelpost, which, together with the land-wheel lever, are used in leveling the plow and in changing the depth of furrow.

At the top of the front furrow wheelpost there is, usually, a little shift lever which is independent of the connecting rod and is used to change the angle of the front-furrow wheel. The pole is also attached to an iron extension with a hinge joint coming from the top of the front furrow wheelpost.

Most frame riding plows are now equipped with a foot-lever lift. This is a double lever within easy reach of the operator's foot, and is used to raise and lower the plow, after the desired depth has been secured, by adjusting the land- and furrow-wheel levers.

The plow bottom is swung under the frame by long supporting rods which are attached to both sides of the frame and to the plow beam. There are bearings in all 3 connections, so that the plow will work up and down freely. These supporting rods are known as bales. Some plows are made with a single bale; others, with a double bale, one in the front and one in the rear.

A rolling colter is usually placed on a riding plow. This is a heavy, sharp iron disc, attached by a yoke and spindle to the beam in such a manner that it runs just ahead of the inside edge of the moldboard, cutting both trash and soil so that a clean, even furrow may be turned.

**Gang plows.** The 2- and 3-bottom horse-drawn gang plows have been developed from the sulky. The usual gang plow is of the frame type, having a foot-lever lift and being locked in the ground, like the sulky, as described above. The 2-bottom gang is the one almost universally used. Especially is this the case since the advent of smaller tractors, which usually pull 3 bottoms. The 3-bottom horse gang is cumbersome, and requires so much horsepower that the teams are unwieldy.

Walking gangs are made for use in certain localities, such as the wheat country in the state of Washington, where large areas are to be plowed each year, but where the land is rolling, making the use of riding gangs more or less inadvisable.

**Tractor gang plows.** The tractor gang plow is a very recent development, and in the course of the last few years has seen many changes. The original tractor was designed to draw a heavy load. Consequently, heavy plows, ranging from 6 to 12 in numbers, were designed. Most of these plows have gone to the Great Plains states and Canada, where the land is quite level, and a tremendous acreage is plowed each year for seeding the following spring.

All heavy tractor plows are constructed with the beams attached to a heavy frame the rear portion of which is set on a diagonal. The beams are supported close to the moldboard by a guide wheel, and are held apart by some form of spacer. Originally, each beam was supplied with a hand lever and it was necessary for one man to ride on the plow to operate it. The demand for the use of less labor quickly caused the development of power lifts, so that at the present time practically all tractor plows are supplied with some sort of mechanical lift. Some of these lifts are so arranged that the plows are raised in order, starting with the one on the inside. Others lift two bottoms at once. They are all effective and answer the purpose for which they are designed, namely, in doing away with the necessity of a man on the plow. As indicated above, the general tendency is to

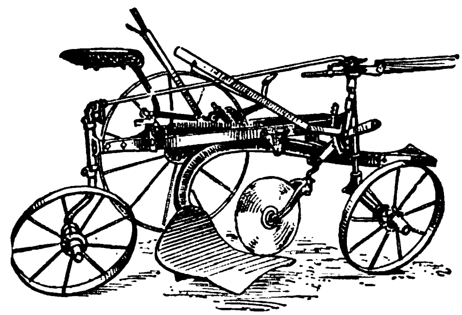


FIG. 114. Beam hitch, foot-lever lift, one-bottom sulky plow

reduce the size and weight of tractor plows. Even on large farms, smaller tractors are being used; consequently, lighter plows are necessary. The ordinary 3-bottom tractor plow is built with the beams securely fastened together instead of each one being free, as in the lever types, and the lift necessarily brings them all up together.

**Reversible or hillside plows.** The reversible, or hillside, plows, as they are variously called, are made both in the walking and the sulky types. The sulky is constructed with 2 plows, a right- and a left-turn, suspended in a single frame. The mechanism is so designed that first one and then the other plow may be lowered, so that the operator can cross the field, plow a furrow, turn around, lower the other plow, and come back, plowing a slice in the furrow just opened up. In this way, he can go back and forth across the field without making a dead furrow or plow in lands.

In the walking plows, the bottoms swivel for either right- or left-hand furrows, so that the land can all be plowed one way. They can be equipped with either jointer or colter which shifts automatically with the bottom. Such plows are used in experimental fields, where the presence of a dead furrow is undesirable, and on rolling and hilly land where it is de-

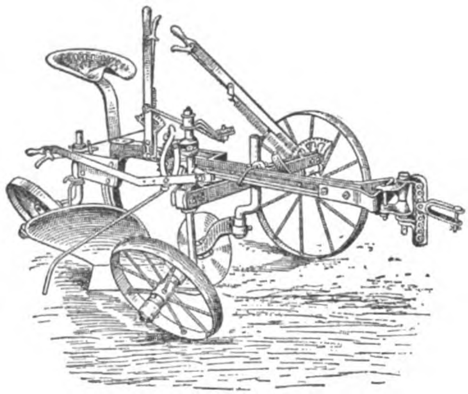


FIG. 115. Frameless, lever-lift type of riding plow. It has the advantages of light weight, low cost and short coupling, making sharp turns possible.

sirable to plow across the slope in order to prevent washing.

**Disc plows.** Disc plows are made in both sulky and gang sizes as well as larger units for tractor use.

The disc plow is a distinct departure from the ordinary moldboard plow so common throughout the country. Instead of a moldboard, a heavy steel disc is used, which is set at an angle and revolves around a centre pin or axle. As the plow is pulled forward, the disc both cuts and turns the earth in a well-defined furrow. The disc plow is invariably of the frameless type and is operated by hand levers. It is heavier and does not handle as easily as the moldboard types.

Plows of this type are used extensively in territories where the soil is hard and dry when plowing is to be done, or where there is difficulty in getting the moldboard plows to scour. There are many such places in Texas and northward over the Great Plains states. Farmers in Argentina, South America, also, are buying disc plows from the United States, particularly plows for use behind tractors.

**Deep-tilling machines.** The deep-tilling machine is a development of the disc plow. It is built like a gang disc, but with the back disc set directly behind the front one. It is so designed that the front disc throws its furrow slice and the back one cuts its furrow slice out of the bottom of the furrow just made. In this way very deep plowing can be done. Plowing in this manner to a depth of 12 to 18 inches seems to be most beneficial in regions of light rainfall. The loose, plowed soil collects and holds moisture much better than it will otherwise, thus practically insuring a crop.

In regions where rainfall is plentiful, deep tilling has not yet proved remunerative. While connected with the University of Missouri, the writer made an unofficial test, comparing deep tilling done in both fall and spring with ordinary plowing also done in both fall and spring. The lands plowed were in long strips in the same field and as nearly uniform in fertility as could be selected. The whole field was planted to corn the following spring. Little difference could be observed, except that the corn on the land deep tilled in the spring was somewhat poorer than the rest. This would seem logical, as soil was thrown out on top that had never been disturbed before, and had not felt the action of those agencies that make plant food available.

**The subsoil plow.** Like deep tilling, the practice of subsoiling has shown itself to be most beneficial in regions of light rainfall. The subsoil plow follows directly behind the surface plow stirring the soil in the furrow bottom. Sometimes a small moldboard plow is used, or a single-shovel plow that stirs the soil in the bottom of the furrow without mixing it with the topsoil. Another type of subsoil plow has a long, narrow point with a thin cutting blade that simply splits the furrow bottom to a depth of several inches.

Subsoiling is done with three main things in view: to increase the water-holding capacity of the soil; to allow the air to enter the soil more freely; and to encourage deeper penetration of plant roots. As mentioned, this work is most practical in regions of light rainfall. Farmers in more humid sections find it more profitable to do their subsoiling with deep-rooted clovers.

**Sizes and types of plows to use.** The lay of the land, together with the size of the farm, will determine whether one should buy a walking, sulky, gang, or tractor gang plow. The larger types of implements do as good, and often better, work than the smaller ones. Their use invariably means cutting down the cost of crop production. When labor saving is greater than interest charges this is doubly appealing to the business farmer, because it means an actual saving of money and another link in the solution of the farm-labor problem. Data from the Ontario Experiment Farm show that the cost of plowing has been reduced there from $2 per acre, with a single

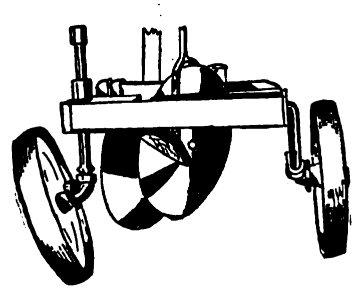


FIG. 116. Deep-tilling machine built on the double disc principle

plow, to $1.25 per acre with a 2-furrow gang plow. This reduction is largely due to the fact that one man less was required to accomplish the same amount of work.

**Sulky and gang-plow adjustments.** The foot-lever-lift type of sulky and gang plows have special means of adjustment which should be thoroughly understood by every farmer, as they have much to do with the proper operation of the plow.

Both the front and rear furrow wheels of either a sulky or a gang plow should run straight ahead and toe squarely into the angle of the furrow. The rod connecting the two furrow wheels can be shortened or lengthened to overcome any difficulty with the rear furrow wheel. The angle of the front furrow wheel is controlled by the pole, or a special lever device at the top of the front furrow wheelpost. On practically all makes of plows, the iron to which the pole is attached is reversible, and can be shifted in such a manner as to make the pole stand square. If the front furrow wheel does not toe into the angle of the furrow, the wheel can usually be shifted on the axle until it is in the desired position.

In some makes of plows, the position of the rear furrow wheel can be changed by a simple adjustment in the rear, which causes this wheel to hug the furrow bank closer and in that way take off the pressure from the landside. If this is not done, the landside will drag and in a very short time will wear to a thin sharp edge on the lower side and will gradually wear completely out. Where this pressure is taken from the landside, the draft of the plow is considerably reduced.

If the plow does not take the ground properly, even though the levers are down, it should be given more suck. Practically all plows have an adjustment whereby the pitch of the beam may be raised or lowered, in order that this may be accomplished.

Other common causes of lack of penetration are dull rolling colters, dull shares, and a slipping of the frame on the rear furrow wheelpost.

Keep the colters sharp enough to cut through trash, stubble, or sod as the case may be. In dry ground, set the hub of the colter about 3 inches back of the point of the plow and in stubble land it is only necessary to run it from 1½ to 2½ inches deep. In sod, the colter should cut through the mass of roots, if a good job is to be done.

Shares should not only be kept as sharp as possible, but should be set as nearly like a new one of the same make as can be done. Various makers have ways of their own for sharpening and setting shares, the appearance of which should be maintained. To do this, it will be necessary to keep a new pattern share on hand to serve as a model for the blacksmith.

As mentioned above, the rear furrow wheel should take the pressure from the landside. In most frame plows, the frame is supported on the rear furrow wheelpost by a collar and set screw. If this adjustment slips, the frame sags down, and the plow is running like a sled with heel down and point up. In this case, raise the frame until there is a half inch clearance under the heel of the landside when the plow is standing on a level surface.

One of the great difficulties of most 2-bottom gang plows lies in the fact that they develop side draft. This is particularly true where 4 horses are hitched abreast. In order that a gang plow may pull straight ahead like a wagon, the hitch must be placed to pull from about the centre of the line of actual draft, then the equalizers must be so built that the pull of the 4 horses working together comes back to this point.

Many plows are so constructed that it is practically impossible to run them without side draft when 4 horses are working abreast. In that case, it is much better to use a strung-out hitch. All gang plows will work better with a strung-out hitch than where 4 horses are used abreast; and where 5 horses are used, this type of hitch should be the only one considered.

Where the horses in the team do not work at the same speed, or where there are one or

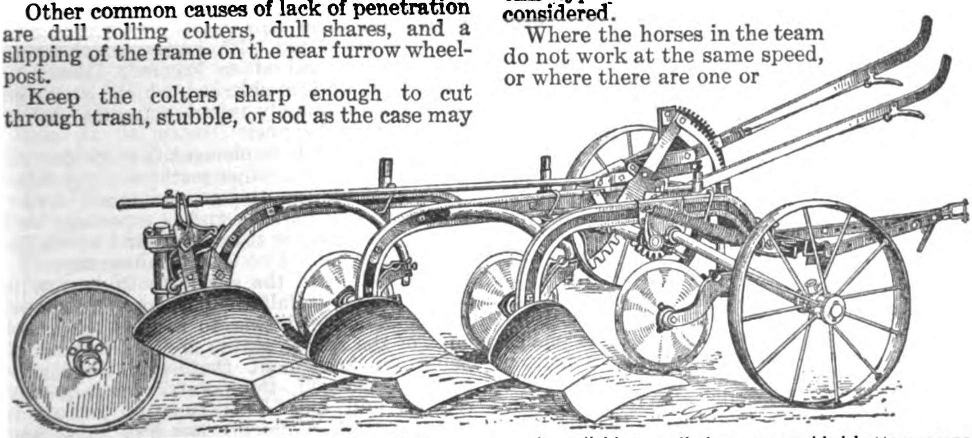


FIG. 117. A three-bottom tractor gang plow. As long as power is available to pull them every added bottom means one more man released for other work

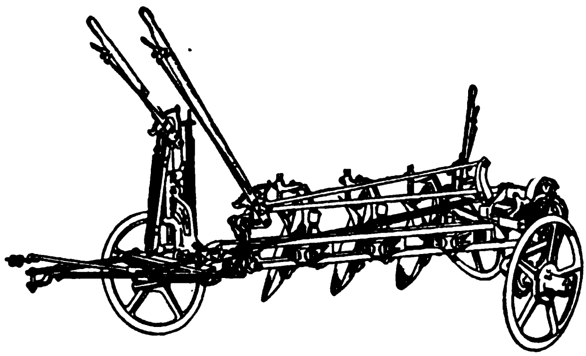


FIG. 118. A three-disc tractor plow; a type especially fitted for use in hard, dry soils or where moldboards fail to scour well

more lazy animals, it is a good plan in making a strung-out hitch to attach a pulley at the hitch on the plow, run a chain through this pulley, attaching one end to the rod running out to the lead team and the other end to the rear equalizer. This will make one team pull against the other and prevent lazy horses from shirking.

**Correct engine plowing.** Lay off the field in headlands from 200 to 400 feet wide, so that dead furrows will not be too frequent, and still the time consumed in traveling across the ends will not be excessive. Leave strips at each end wide enough to turn on with ease. Leave a strip of the same width on each side of the field. When the headlands have been plowed, start around the field, plowing out ends and side strips. In this way, the whole field can be nicely plowed out, except the corners.

Plowing in a circle leaves unplowed strips at first, when turning is short, and leaves too much unplowed and in the corners. Such plowing is also very hard on the plow, which is in a position of constant strain all the time. The life of a plow so used will necessarily be short and the quality of its work inferior.

## Harrows

There are 3 general types of harrows in use: the drag, or spike-tooth harrows; the spring-tooth harrow; and the disc harrow. All of these have variations in design which make them adaptable for various purposes.

**Drag harrows.** There are 3 common types of drag harrows in use. The rigid wood-bar harrow which is made by driving the sharp spike teeth through a solid bar of wood and bolting these bars together to form a section. The bars are arranged in various ways, in the attempt to make a strong harrow, but, usually, the same purpose is served. These harrows have no levers, and the teeth are generally set at a slant which can never be changed. Their use is more common on level lands, where very little trash can accumulate on the surface after plowing is done.

The same construction is used to form another harrow in which the teeth are driven through wooden bars; but here the harrows are equipped with levers, and the teeth can be adjusted to practically any angle. This harrow is very similar in construction to the steel-bar-lever harrow; but, in the latter, the teeth are bolted firmly to steel bars, generally U-shaped, to secure greater strength. In both cases, the harrows are made up in sections and are sold usually ranging from 2 to 4 sections to the harrow. The choice between these 2 harrows is purely a matter of opinion. The wood-bar-lever harrow is a little lighter, and usually the teeth stay in position somewhat better than on the steel-bar types.

A variation of the drag harrow is found in a small harrow attachment for sulky and gang plows, which is attached to the plow and breaks up the soil at the same time it is turned over. Where soils are not too heavy, this attachment does exceedingly good work and can be universally recommended.

**Spring-tooth harrows.** A spring-tooth harrow is made with curved spring steel teeth which are firmly bolted to wooden or iron bars. The new types of spring-tooth harrows are fitted with levers, so that the teeth can be raised or lowered. Many of them have an iron side bar, which, when the teeth are completely raised, acts as a sled to transport the harrow.

The use of this implement is more general in the East than in other sections of the country. It works up the ground much deeper than the drag harrow, and is especially well adapted to stony or stumpy ground where the disc harrow cannot be used to advantage.

A variation of the spring-tooth harrow is found in the alfalfa cultivator. This tool was made by bringing to a point the broad ends of the spring teeth, so that, instead of being an implement that will thoroughly tear up the soil, the pointed teeth merely scratch and dig. This type of harrow is very efficient in digging out blue grass and weeds which come into alfalfa fields, but does no harm to the alfalfa plants themselves.

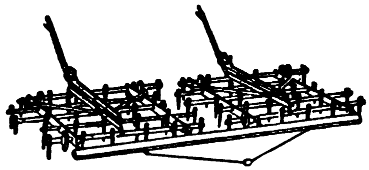


FIG. 119. Spike- or peg-tooth or drag harrow, one of the commonest of farm implements

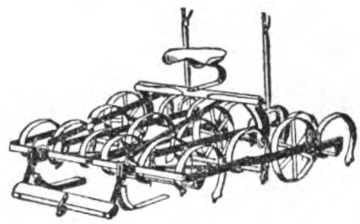


FIG. 120. Spring-tooth harrows are especially popular in eastern sections. This is a riding type with runners and wheels

It makes, therefore, an ideal implement for the cultivation of alfalfa.

**The acme harrow.** The acme harrow is constructed of long, heavy knife blades attached at the forward ends to a heavy bar. Each blade is notched about the middle, the front part curving slightly in one direction and the back part curving in the opposite direction. These blades are set about 8 inches apart, or close enough to thoroughly work the soil.

This peculiar construction allows the acme harrow to cut and slightly turn the soil, making it an efficient implement in the preparation of a seedbed. It both levels and pulverizes, thus doing the work of disc and drag harrow at the same time.

This harrow may be found in all sections of the country, but is especially esteemed in the East. In the corn belt the disc harrow has displaced the acme because of the ability of the former to prepare a good seedbed on stalk land for spring seeding without the use of a plow. The disc is also more effective as a pulverizer on plowed land.

**Disc harrows.** The disc harrow is a comparatively recent invention, differing so widely from ordinary harrows that it seems more akin to the plow than to the harrows. In action it both cuts and turns the soil, doing more to pulverize and compact it, as well as to kill weeds, than any other farm implement except the plow.

The disc harrow serves in more useful ways than any other tool on the farm. It has been found that stalk land when thoroughly disked is in splendid condition for seeding spring grain.

Land to be planted to corn, cotton, and other cultivated crops should be disked ahead of the plow, as loose fine earth is then turned down to the bottom of the furrow slice, where most of the roots of any growing crop will be found.

Plowed land should be disked to prepare for a cultivated crop, as weeds can be quickly and easily killed in this way. The ground is made fine and mellow on top and compacted somewhat beneath. This is the best kind of seedbed for any crop.

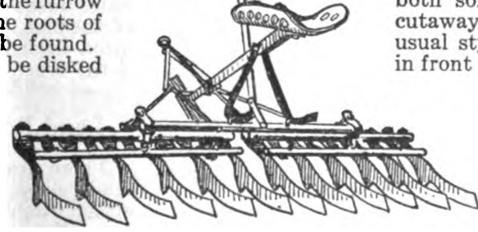


FIG. 121. The acme harrow leaves a splendid seedbed, but for best results it requires a soil in good condition in the first place.

Hard, dry ground may be put in shape for plowing by first using the disc. Even a light mulch will cause the retention of enough moisture, as it rises from below, to cause the soil to become mellow enough for satisfactory plowing.

Where stubble lands are to be fall plowed it is an excellent practice to run a disc directly behind the binder; the soil then does not become dry and hard, and can be plowed to advantage any time after the crop is removed. When a tractor is used to pull the binder, the disc may be tied directly to the binder, as there is plenty of power to handle both.

**Construction of disc harrows.** The ordinary farm disc harrow may be made with solid discs, with cutaway discs, in which portions of the outer edge of the discs are cut out, leaving squared-off projections which are intended to dig a little better, or with spading discs. Instead of a solid wheel, the spading disc is cut into many sections completely down to the axle, the idea being to increase the power to penetrate the soil to greater depth.

Actual experience has shown, however, that the solid disc, when kept well sharpened, not only wears better, but usually does better all-'round work, than the other types.

**Tandem disc harrows.** The tandem disc harrow is formed by attaching a trailer directly behind an ordinary farm disc. This trailer throws the soil in the opposite direction to the first set of discs. When the ground is gone over once with this implement it is cut twice. The saving of time is an important item and the work is generally very satisfactory. Tandem disc harrows are made both solid in front and rear or cutaway front and rear, but the usual style is to use solid discs in front and cutaway in rear.

**Reversible disc harrows.** Another variation of the ordinary farm disc is what is known as the reversible harrow. This implement is made by attaching a gang of discs to the frame by means of an upright spindle,

FIG. 122. Orchard harrow extension

set up close to the outer edge of the gang. When in one position, the implement looks like an ordinary disc harrow, but the gangs can be swung around so as to leave a wide space between the two. This type of harrow is found in common use in the South in preparing for cotton. It is of special advantage in throwing down the ridges made by the cultivation of cotton, corn, or sweet potatoes. The reversible feature allows this work to be done to the best advantage.

**Orchard harrows.** The orchard harrow is made on the same principle as the reversible disc, but the disc gangs are placed out on the end of an extension. This construction makes it possible to work under trees to good advantage with a disc harrow, which could not be done with an ordinary implement. These tools are coming into general favor in practically all sections of the country where orcharding is followed as a business.

**Tractor disc harrows.** Disc harrows, both single and tandem, are now being made for use behind tractors. They are built along the general lines of the ordinary disc harrow, but made heavier throughout. The style of disc is the same as for horse-drawn harrows, being either solid or cutaway, or both. They should always be equipped with tongue trucks and weight boxes, in order that sufficient weight may be put on to make them take the ground to best advantage. There is usually plenty of power when the tractor is used so that a good job of disking may be done. Double disking in this manner where oats, spring wheat, or barley is to be seeded on


FIG. 124. Wheat plots comparing results of growing oats before seeding (*a*) and of summer cultivating or fallowing (*b*)

stalk land in the corn belt, is becoming a favorite practice and gives excellent results.

**Disc harrow sizes.** Disc harrows are made in a wide range of sizes, both as to length and height of discs. The 16-inch disc has proved the most popular, however, and the bulk of disc harrows sold are of this height. The length of the disc harrow depends on many things, principally the work to be

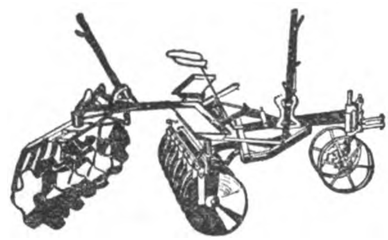


FIG. 125. Combined disc and cutaway harrow

done and the horsepower available. In the corn belt, 2 sizes predominate—the 8- and 10-foot discs. The 8-foot disc will take 2 corn rows nicely when disking stalks, leaving a short lap. The 10-foot disc will just uproot 3 rows. The 9-foot disc will not reach the third row, consequently it leaves a wide lap. It takes more horsepower than the 8-foot, and is no more efficient. It is, therefore, being rapidly discarded in favor of one of the other sizes.

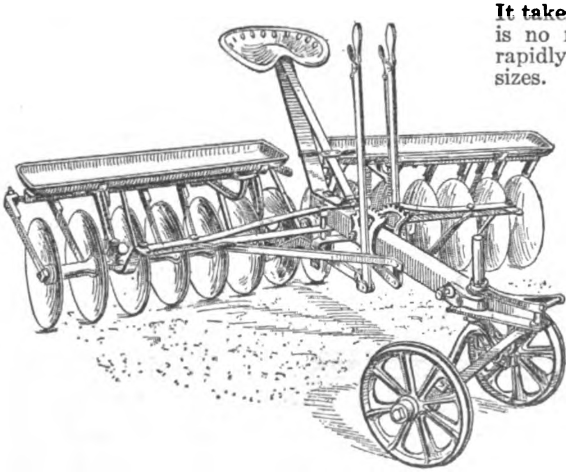


FIG. 123. A tongueless disc harrow, the truck serving to reduce the draft, which in any disc machine is considerable

**Tongue trucks.** A tongue truck should always be used on a disc harrow. It steadies the disc, so that better work can be done, and at the same time takes the weight off of the horses' necks. It also eliminates most of the violent swaying of the pole which always annoys and often injures the animals next to it if the truck is not used.

## Land Rollers and Packers

There are three distinct types of land rollers in use—the flat roller, either iron or wood, the corrugated iron roller, and the subsurface packer.

**Flat rollers.** Flat rollers are designed as clod crushers, and have

been used for this purpose almost exclusively. It has been found, however, that land rolled down smoothly is crusted badly by a heavy rain. In addition, as capillary water rises to the surface, evaporation takes place much quicker from the smooth, compact surface.

Both of these conditions have been so universally noticed that the use of a drag harrow following a flat roller is always recommended.

**Corrugated rollers.** Corrugated-iron rollers are made with either solid or hollow iron wheels which come to a rather sharp edge on the outer circumference. This corrugation may be from 1 to 3 inches deep, curving out to form a flange on either side. The edges of the flange on adjoining wheels touch one another leaving the corrugations from 3 to 5 inches apart. It will be readily seen that not only will this type of roller crush clods, but that the corrugations will cut into the soil, causing some subsurface packing.

Corrugated rollers are made on a straight spindle or in sections. Those made in sections are more flexible and will do a better job where the land is uneven.

The heights of the roller wheels vary widely, most of them ranging from 16 to 20 inches. These higher wheels are used exclusively on the single rollers. Where a trailer is used, forming a double roller, the height of the wheels is greatly reduced, ranging from 8 to 12 inches.

The question is often asked as to which type of roller is to be preferred. Both single and double rollers do good work. The single roller is a little easier to handle in stalk land that has been disked up for oats or other small grain. Where the soil is very mellow and contains stalks or trash, this material is apt to push ahead to a certain extent of the small-wheeled roller. Other than this, little criticism can be made of either type. Every farmer who grows corn and small grain should have a corrugated roller.

**Rolling spring-sown grain.** Where oats or other small grain follows corn, the land is usually disked and the grain broadcasted or drilled. In either case, the corrugated roller can be used to great advantage as the last thing in the seedbed preparation. In Grundy County, Illinois, members of the Agricultural Improvement Association made tests showing the effect of the corrugated roller used at this time. Where oats were broadcasted, the stand was increased about 30 per cent. This was evidently due to pressing kernels, that had not been covered, into the soil, and also to the fact that the soil was pressed firmly around practically all the seed, holding the moisture and thus causing rapid germination. Usually, in broadcasting, many kernels lie near the surface, or in crevices where there is little or no fine dirt, dry out shortly, and never grow.

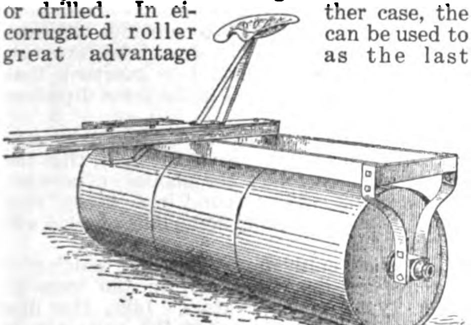


FIG. 126. Common, metal land roller, an implement that could and should be more widely used

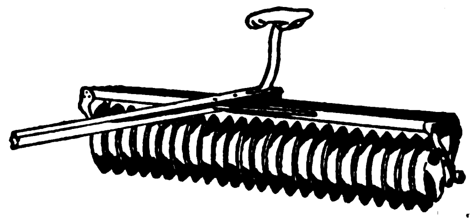


FIG. 126*a*. One form of soil packer, an implement particularly useful on light, loose soils

**Rolling winter wheat and other small grain.** Rolling winter wheat in the spring as soon as the ground is dry enough to work is an exceedingly profitable practice. The roller closes the cracks left by the freezing and thawing weather of early spring. This not only covers the exposed roots, but saves moisture. In a few days after rolling, a piece of wheat that has appeared quite dead, and which probably would never have come out except under the most favorable weather will begin to show life.

Oats, barley, and spring wheat can all be benefited by rolling in a dry spring, even after the plants are 3 or 4 inches high. It will be better, however, to roll at the time of seeding as explained above.

**Rolling ahead of the corn planter.** In any section where corn is grown, it is excellent practice to run a corrugated roller ahead of the planter. This firms the land sufficiently to enable the corn to be planted at a uniform depth; neither does the planter run too deep.

It is common practice in the corn belt to use the drag harrow as soon as planting is finished, usually crossing the rows. If the ground is very mellow and not rolled, the corn planter tracks are filled, burying the corn from 3 to 5 inches deep. Under this condition, even in favorable weather, the vitality of the seed is exhausted before the plants get out of the ground, and in cool, wet weather the kernels often rot.

Where the roller is used, the corn is planted shallow; and, if the soil is dry, the compacting of the roller causes enough moisture to rise and collect around the seed for germination. If the weather is wet, the seed is still close

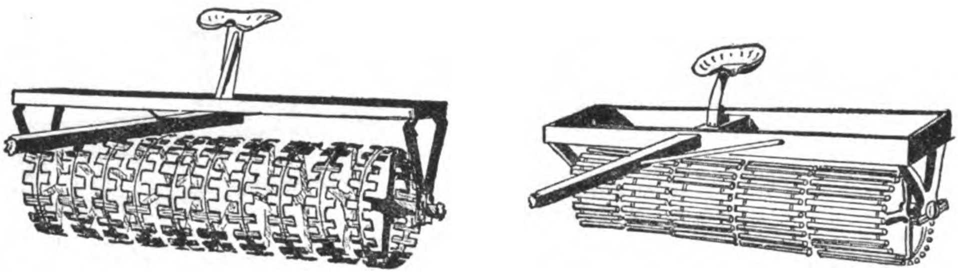


FIG. 127. Two modified forms of subsoil roller or packer. Implements of this type have been most developed and most utilized in the dry-farming operations of the semi-arid West

enough to the surface to get enough air to prevent decay.

**The subsurface packer.** The subsurface packer is more like a corrugated roller than any other tool. The wheels are farther apart, generally open, with a sharp rim. It is the object of this tool to cut rather deeply into the soil, splitting clods, and, most of all, to firm the bottom of the furrow slice.

The subsurface packer has found great favor in regions of light rainfall, where a seedbed that is firm underneath and fine on top holds moisture to best advantage and presents the most ideal condition for the growth of crops.

## Cultivators

There are a great many cultivators on the market and they present a large number of varieties of construction and manner of operation, most of which, however, are but different means of accomplishing the same end. All cultivators may be divided into 4 classes, according to construction—shovel, disc, spike-tooth, and surface—and into 2 general classes, in reference to soil topography, namely, those adapted to hilly fields, and those for use on level or slightly rolling lands.

**Pivot-frame and pivot-axle cultivators.** With hilly fields, the best practice is to cultivate them across the slope, to prevent washing. This procedure presents a difficulty at the outset in managing the cultivator.

For this kind of work there are 2 general types of cultivators now in use, the pivot-frame and the pivot-axle. Both of these implements allow the operator to incline the wheels up the slope, in order to keep the machine to its work. The pivot-frame accomplishes this by changing the direction of the pole, without interfering with the team, while the pivot-axle works directly on the wheels, changing their direction immediately, according to the way the operator pushes his foot. In both implements the same device is used in dodging, whenever this is necessary.

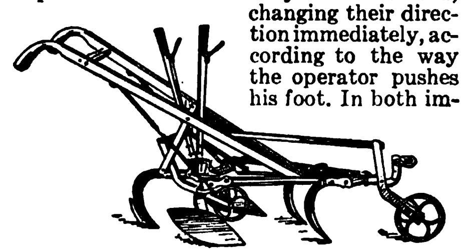


FIG. 128. The one-horse, single shovel plow was one of the first cultivators and the ancestor of our modern highly efficient soil-stirring implements.

**The two-row cultivator.** On account of the growing scarcity of farm labor, the 2-row cultivator is coming more and more into favor on the larger farms, where the land is not so rolling as to prevent its use. Many makes are now so improved that the work that can be done with them is equally as good as that of the 1-row machines, while the cost of the work is greatly reduced.

A good 2-row cultivator must have a strong, well-supported frame, to prevent sagging. A multiplicity of levers should be avoided. The dodging action should be positive, that is, the gangs should shift in the same direction as the foot is pushed.

It should be borne in mind, when using a 2-row cultivator lengthwise of the field, that the cultivator must follow the planter, otherwise, a little crook will be found in one row that is not in the other, and some hills of corn will be plowed up.

**The disc cultivator.** The disc cultivator is a distinct departure in principle from all other types of cultivators. Like the disc harrow, it cuts and turns the soil instead of tearing it. It is especially adapted to

land infested with morning-glories, quack grass, smartweed and other strong-growing weeds that are hard to eradicate. The discs will not dodge around a tough root, and are not easily loaded up as is a shovel or scraper blade.

The gangs of a disc cultivator are reversible, and can be set to throw the dirt toward the crop or away from it. Each cultivator should be supplied with knife levelers which work in the opposite direction to the gangs, thus preventing hilling the corn or leaving a thin bare ridge when throwing the dirt from the crop.

**The listed corn cultivator.** This cultivator also is of the disc type, and is usually built as a 2-row machine. Listed corn is planted in the bottom of a trench; and it is the object of this implement to fill the trench gradually, as the corn grows, until the land is level enough to use an ordinary cultivator.

This cultivator has a low, heavy frame to which the cultivating gangs are attached. They have free side play through roller bearings. This enables the discs to follow the trenches, and avoids cutting out the growing crop. The success of this cultivator depends, therefore, on its ability to follow the inequalities of the trenches closely.

**The surface cultivator.** The surface cultivator is usually fitted with 2 scraper blades on each side, in the place of shovel gangs. Each blade is attached to a single standard, where adjustments to change the angle and pitch of the blade are provided.

The tending of all kinds of cultivated crops with this tool is rapidly coming into favor. Owing to the fact that the blades may easily get out of position and do little or no good instead of the first class work of which they are capable, the following specific directions are given for adjusting a surface cultivator.

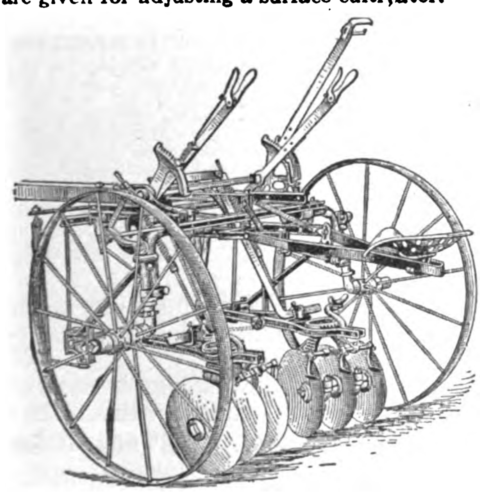


FIG. 129. Steel frame disc cultivator with discs set to hill up along the row

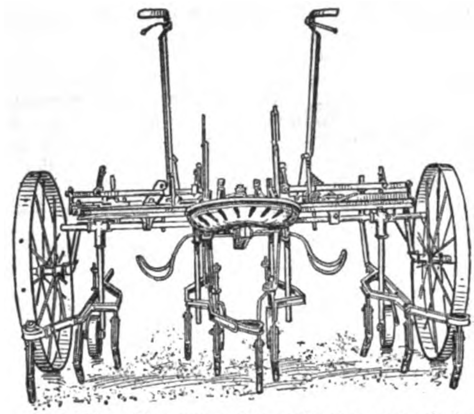


FIG. 129*a*. Two-row, riding cultivator, one of the means by which a farmer can win his battle against drought and weeds.

**How to adjust a surface cultivator.** Prepare the cultivator for the season by sharpening and polishing its blades.

Surface cultivators are usually supplied with 2 blades which are somewhat narrower at the heel and 2 which are of the same, or nearly the same, width throughout. Place the narrow pair on the outside, and have the other pair trimmed down by a blacksmith to not more than 2 inches at the heel. Place these next to the row. Run the machine on a level surface—a floor or a plank will do—raising the tongue to the height carried by the team.

Loosen all set nuts, using kerosene and oil, and level all the blades with the surface on which the wheels rest; set them as nearly flat as the knuckles or blades will allow, and with as little angle to the row as will safely cover the surface. It will be found that the blades will clear themselves of trash best if the point runs slightly higher than the heel. This is particularly true in spring-plowed stalk ground. Use a rigid shield; if the machine is supplied with a floating shield, lock it. Place the blades about 4 inches apart and just high enough to permit enough soil to run under them and reach the row covering the small weeds that may have started at the hill. Blades should run only deep enough to keep soil flowing over them thus leaving a mulch between rows.

For the second cultivation, lower the standards carrying the outside blades a half inch. Move the gangs a little farther apart and turn blades to a slightly greater angle with the row. This will be the deepest cultivation. At any rate, the following cultivation should be more shallow. For the third crossing, lower the outside blades another half inch and set the gangs farther from the row.

The fourth cultivation should lay the corn by; set the outside blades flat once more, and raise the inside ones at the heel, so that they

will only have the dirt run over them when crossing the ridges.

Don't stir loose dry soil, if not weedy; and don't get close to corn when ground is wet, thinking it will do less harm to the roots. Don't cultivate in wet soil anyway, if you can help it. Try to move just as little soil as possible. Have a good seedbed, and make it as level as you can. Don't be afraid to get close the first time, but keep away the third and fourth.

Remember the machine may get out of adjustment. Check up on the blades often by placing a straightedge under them. Never let any blade scrape the loose topsoil away, if it won't stay under, find out why.

**The weeder.** The weeder is really a spring-toothed cultivator with very narrow pointed teeth. These tools are built in sizes to take from 2 to 4 rows at a time. The 3-row weeder is the size usually found in the corn belt.

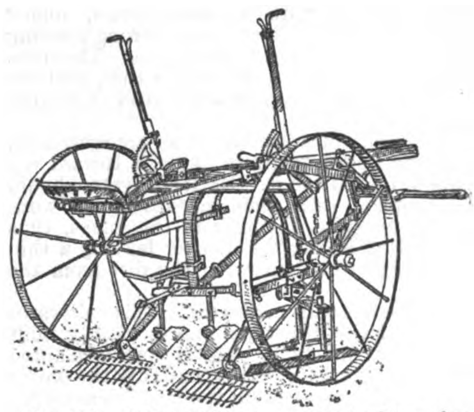


FIG. 131. Riding cultivator equipped with surface cultivator blades and, behind them, surface smoothing rakes to break down clods and ridges.

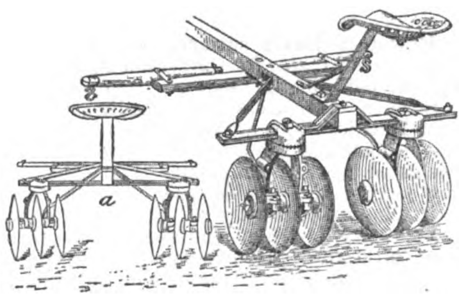



FIG. 130. Reversible riding disc harrow, with the discs set close so as to throw the soil away from the row; and (a) with discs spread and reversed so as to straddle a row

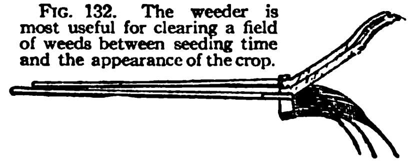
The most improved types of weeders are mounted on wheels and equipped with a spring-pressure lever to adjust the depth of the teeth.

A weeder can be used to advantage in tending practically any cultivated crop during the first period of its growth. Where the weeder is run over a field just as the crop is coming up, any crust that may have formed is broken and the sprouting weeds are destroyed in great numbers. This operation can be repeated in a few days and will both keep back the weeds and leave the ground in such good condition that the crop will generally get to a sufficient height to be easily cultivated before it is necessary to put a cultivator in the field.

## Shovel versus Surface Cultivator

We usually expect to attain 3 objects by cultivation, namely: to kill weeds, to save moisture, and to aërate the soil. The University of Illinois has made repeated tests which show conclusively that killing weeds has more effect on the crop than any other factor, and that cultivation need only be deep enough to accomplish this. This being the case, the use of a shovel cultivator throughout the growing season, especially if run to any depth, is harmful since many of the roots of the crop are badly pruned by it while the weeds are being eliminated.

FIG. 132. The weeder is most useful for clearing a field of weeds between seeding time and the appearance of the crop.

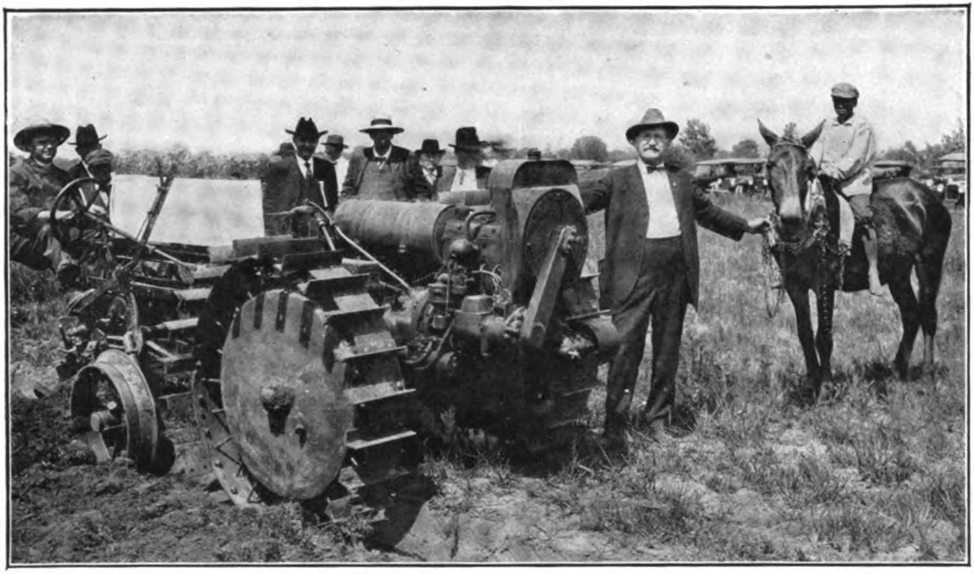


Many of the best corn growers over the whole country are using surface cultivators altogether. Many more are using combination rigs, discarding the shovels after the second cultivation in favor of the scraper blades.

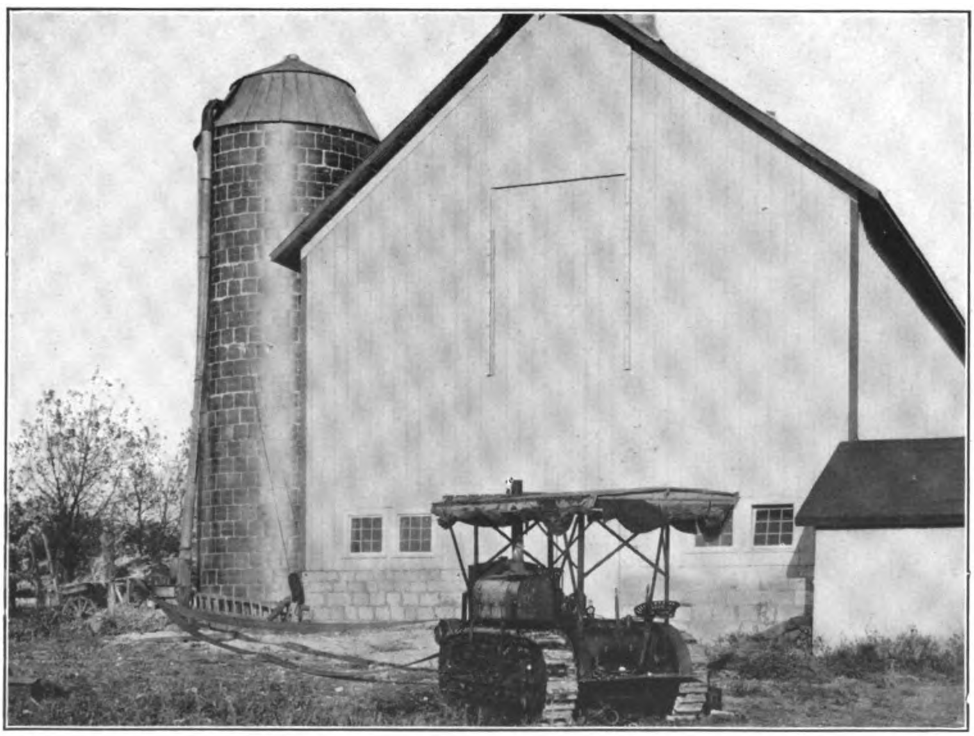
Practically all of the machines described above, except the disc, can be secured equipped with shovels or scraper blades. Owing to the importance of this matter of cultivation, it is advisable, when buying a new cultivator, to get one that is interchangeable for shovels and scraper blades.

**Above, a light delivery truck well equipped with springs for the handling of easily damaged produce. Below, a powerful type equal to any task that a farm can impose**

**MOTOR TRUCKS ARE MADE IN ALL SIZES, TYPES, AND CAPACITIES. THE FARMER WHO REALLY NEEDS ONE HAS BUT TO CHOOSE THE KIND BEST SUITED TO THE MAJORITY OF HIS NEEDS**



The old and the new in farm power. In the South "40 acres and a mule" is giving place to "400 acres and a tractor," and similar changes are occurring everywhere



A small tractor of the caterpillar type operating an ensilage cutter

THE SMALL FARM TRACTOR AS A COMBINATION MOVABLE AND STATIONARY SOURCE OF POWER IS ALMOST REVOLUTIONIZING CERTAIN PHASES OF FARM WORK

FIG. 133. Potato planter of the force feed type. The man in the rear feeds the seed pieces to the dropping mechanism

# CHAPTER 8

# Machines for Seeding and Planting Crops

*By* F. H. DEMAREE *(see Chapter 7) who says of the implements described here: "As Agronomist with the J. I. Case Plow Works, I was afforded ample opportunity to study the construction and operation of all kinds of corn, cotton, and peanut planters and listers. I found, as most people finally do, that it is the successful operation of a machine that appeals most to the farmer. In most cases a great deal can be accomplished simply by following the directions given by those who make and know the machines. In following the work of drills and seeders in many sections of the country, I find that it is essential to get the style of furrow-opener that best suits local field conditions, then to standardize the drill every season. In starting my drill, I measure the correct amount of seed for 1 acre into the drill then set the drill as nearly as I can to sow that amount. I keep changing the feed until the right amount is seeded. This is the only way to get a proper stand." In view of the tremendous importance of proper seeding, which alone may mean the difference between a good crop and a poor one, the following information—based on practical tests and first-hand observations—should prove of very great value to the farmer.*—EDITOR.

THE development of planters and seeding machines, as we have them now, is even more recent in point of time than that of plows and other tillage implements. In the early days of America corn planting was all done by hand, much of it on unprepared land. Kernels were pushed into the soil with a stick, or covered with a hoe, on a piece of clearing where the burning of stumps and brush had insured the land being free from weeds for a season or more. Even at the time the western prairies were being opened up planting was all done by hand. The land was plowed, furrowed out, then the corn dropped and covered with a hoe.

Later the planter, as we know it now in its essential parts, was developed. The first of these machines of the 2-wheeled type was the old "Step Drop." A boy sat between the wheels and worked a hand lever, dropping a hill at each step of the team. From then on, the drill and check-row types were rapidly perfected.

FIG. 134. Gravity-feed potato planter showing fertilizer attachment in front of driver

The use of drills and broadcast seeders is also very recent. Hand sowing had been the rule from time immemorial until the present day mechanical age brought the development of these machines. The first seeders were all of the broadcast type, represented by a box mounted on wheels with an agitator inside the box and openings for the grain to fall through. This was far from a perfect seeder, but for many years it was the

best available, for the force feed as described in this chapter has not been in existence much more than a generation.

## Planters

**CORN PLANTERS.** Few farm implements offer such direct profit-making opportunities by correct use as do planters and other kinds of seeding machines. Corn planters may be roughly divided into two classes—the round-hole plate machines and the edge-selection planters. Machines of the former class may be subdivided into two classes—the single-cell and the full-hill drop. Both of the first two classes of planters mentioned may have either intermittent or continuous drive.

There can be little doubt that, so far as accuracy is concerned, the single-cell machines have outclassed those of the full-hill drop type; and it is, doubtless, for that reason that the great bulk of corn planters now sold are of the single-cell type, either round-hole or edge-selection plates. There may be considerable advantage in the better machines with intermittent drive, in that friction is considerably reduced and the life of the corn planter is prolonged. The drop mechanism is generally rather delicate, and a quick wearing of the parts is objectionable because it always means inaccuracy. Without proper adjustment throughout and a harmonious working of parts the highest accuracy cannot be obtained, and slight wear is often the cause of inaccuracy.

**Value of individual hills.** There are 3,556 hills of corn on an acre of land, planted 3 feet 6 inches apart. If each hill should produce 1 pound of corn, and a perfect stand be secured, the yield will be 50.8 bushels per acre, basing the field weight on 70 pounds per bushel. If this yield per hill can be doubled, then the yield per acre can be raised to 101.6 bushels.

As the yield increases, many other factors enter in to hold down the yield outside the question of stand, but for any good yield a first-class stand must first be secured. The illustration is introduced to show the real necessity of proper planting.

Careful examination of many corn fields in practically every corn state in the union has shown that often very good farmers have as low as 70 or 80 per cent of a perfect stand. In such cases the farmers have been plowing, planting, and cultivating from 20 to 30 per cent of their land with no prospect of return.

**Round-hole versus edge-selection plate.** Both of these types of corn planter have their advocates. The round-hole plate selects the kernels in their natural position. This is a strong argument in favor of the more accurate drop from this type of plate, as efficiency is bound to decrease when any artificial element, such as changing the position of the kernels in some way which is unnatural, creeps in. On the other hand, it is claimed that as corn varies considerably less in thickness than it does in width, the edge-selection plate is on this account more accurate than the round-hole type. Doubtless the different makes of both of these kinds of planters are accurate when properly operated.

In making a test with these two kinds of plates, the writer found a very interesting thing, which, to the best of his knowledge, had not then been made public. In both planters corn was used which had come out of a car of shelled corn and had only been graded once. There was, consequently, a rather large number of extra large and extra thick kernels in it. After a full planter box of corn had been run through each machine, it was found that the round-hole machine had planted every kernel in the box, whereas the edge-drop machine retained nearly a double handful of these extra thick kernels, which could not slide down into the cells. It became apparent that, if a farmer in using one of these machines did not have extra well-graded corn, after 10 or 15 acres had been planted, these "off-shape" kernels would collect in the bottom of the boxes, and, unless they were cleaned out every night, would seriously interfere with the accuracy of the drop of the machine.

**The value of grading seed corn.** First-class results with the edge-selection machine are practically dependent upon the thor-

oughness of the grading of the corn. This is not so true with the round-hole type, but even this machine gives better results if the corn is well graded. It may be mentioned that the efficiency of graded corn can be materially increased by shelling off by hand the butts and tips of the seed ears, and then throwing the ears into the different piles according to the width of the kernels.

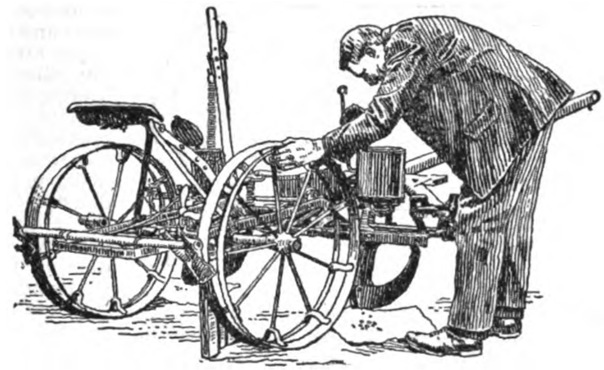


FIG. 135. The careful farmer tests his planters frequently to see that they are giving maximum service

**Testing the planter.** With every planter there is furnished a rather large number of plates, which are designed to cover such a wide range of corn that one set, at least, should give better results than any other with the particular corn to be planted. In judging results it is hardly enough to take a few kernels of corn and see whether or not they fit in the cells snugly or too loosely. The action of the planter while running has some effect in filling the plates. Neither is it enough to take the machine out of the shed, fill it up on the day you expect to plant corn, and then drive off down the road a few rods, letting it plant in the meantime, and then go back and count results. The jar on the machine is very heavy on the road, and more corn is apt to be sent through than will be the case in actual field conditions; hence, results are likely to be misleading.

It is much better to jack up the drive wheel of the planter and put in the plate which is thought best adapted to the corn to be planted; then run through at least 200 hills, if the corn is to be checked, counting accuracy on the basis of 2, 3, or 4 grains to the hill. If the corn is to be drilled, one kernel should come down at each click, which represents a cell as having passed the opening. Different plates tried in this way will often show surprising differences as to the degree of accuracy obtained by the machine, and will be found to have a direct bearing on the percentage of perfect hills that will be found in a field of corn at its maturity.

**Insuring a good check.** On lands that are level or only slightly rolling, the common practice is to check corn, in order that it may be cultivated both ways. Such cultivation aids materially in holding the weeds down. Often, however, the well-laid plans of the farmer are completely blocked by getting the check so poor that it is impossible to plow both ways. It is impossible to set a planter at the factory so that it will check accurately under all conditions. Just take hold of the pole of your planter and lift it up high. It will be seen that the shoes angle very little. The corn will drop almost straight down. Lower the pole, and the bottom of the shoe is several inches back of the seed can. The relative position of the shoe to the button on the wire means a good check or a poor one.

In order to be sure that you have proper relation between these 2 parts, it is necessary, after you have planted the first 2 rows and gone back several rods on the second 2, to get down and dig up several hills of corn. The corn should be found 1 inch or 1½ inches behind the button. If it is found that the corn is not being dropped quickly enough, that is, ahead of the points mentioned, then loosen the bolt that passes through the pole and uprights on the front frame and raise the pole higher. This will make the shoe stand back and allow the corn to drop before passing the button. If there is no such adjustment on your planter, shorten the neck straps which hold up the neckyoke. If the planter is dropping too quickly, that is, more than an inch and a half behind the button, reverse the pole adjustment.

The accompanying cut (Fig. 136) shows 4 rows of corn. The phrase "hill behind button" refers to the way the team is headed. Note the position of the kernels in reference to the button. After turning the team around, the wire is stretched at about the same tension as before, but the pull of the planter brings the buttons back past the spot where they were pulled by the planter on its opposite trip. Consequently, unless the corn drops behind rather than in front of the button each time, it will be badly out of line.

**The clutch.** When checking corn, the clutch controls the speed of the plates as well as the number of holes that pass the cut-off, thus determining the number of kernels planted. On most corn planters the clutch is found on the drill-shaft. Owing to the speed of the drill-shaft and the relative delicacy of the clutch parts, it is subject to a great deal of wear. Any failure to take hold, or slipping on the part of the clutch, is a contributing factor to uneven planting. In recent years one progressive manufacturer has taken the clutch from the drill-shaft entirely and

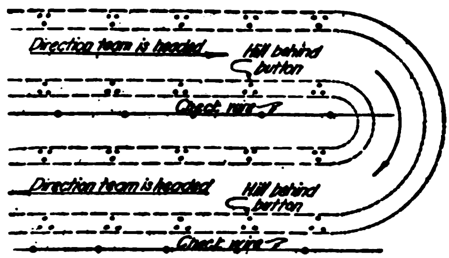



FIG. 136. Diagram to show good checking obtained by careful adjustment (see text, p. 89)

placed it on the axle. The parts are heavy and strong, yet they work with great precision and accuracy.

It is especially desirable to test the clutch of the corn planter thoroughly every spring. Do not take chances with worn parts; get new ones.

**Fertilizer attachments.** Attachments for distributing fertilizer are coming into increasing demand as the fertility of the land diminishes. These attachments are merely large cans, mounted on a support bolted to the main frame of the planter and driven from a sprocket on the axle. From the opening in the bottom of the can a hose leads to the heel of the planter shoe. The amount of fertilizer applied is controlled by the size of opening. The cans are equipped with a force feed device to ensure a constant delivery of fertilizer into the hose.

When using fertilizer for corn in this way, it is always advisable to drill it in the row. If checked in the hill, there is some danger of burning the young plants, or of causing too great a concentration of roots at one spot. Where drilled in the row, the roots spread in a normal manner. In addition, the cultivator usually spreads the material more or less, and the succeeding crop gets a greater benefit from the residue.

**Pea and bean attachment.** The practice of planting cowpeas or soy beans with corn is an excellent one. A special attachment for almost any planter can be secured for this work. These attachments consist of small cans, set immediately behind the corn boxes with hose leading into the planter shank. The gearing is attached to the drill-shaft, so that the plates operate in unison with the planter plates.

Cowpeas or soy beans planted with corn make an ideal combination for silage, hogging down, feeding-off with sheep, or to put in the shock for winter feeding. As near as can be determined, there has been practically no reduction in yield of corn due to the presence of the peas or beans.

**Single-row planters.** Many single-row planters of the walking type are used in the east, south and southwest sections of this country. The plates used in them are the same as in the ordinary 2-row machines.

One other feature has been subject to considerable change, that is, the device by which the plates are driven. Three methods have been used—the chain-drive, shaft-drive, and pitman-drive. The pitman-drive is the most recent and has become very popular, on account of its simplicity and durability. A pitman-rod is attached to each side of the drive wheel, so set as to work alternately. The plate is equipped with extension lugs and one pitman pulls it forward a notch then the other pushes a notch. Thus a hole passes the cut-off at every impulse, and a continuous rotary motion is given the plate.

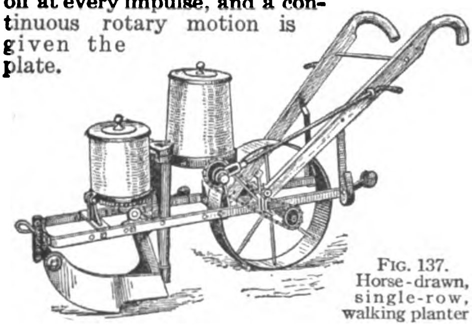


FIG. 137. Horse-drawn, single-row, walking planter

**COTTON PLANTERS.** Regular cotton planters are made both single- and double-row. They are equipped with shovel or sweep to open the row, and with shovels or discs in the rear to cover the seed.

The usual device for getting the seed out of the hopper into the hose leading to the ground has been a picker wheel. This little wheel with many sharp projections revolves in the opening from hopper to hose, tearing the seeds apart and forcing them in a steady stream into the hose. The use of the picker wheel invariably means thick planting, greater cost of seed, and increased cost of thinning.

Recently, there has been patented a cell drop that handles the seed with a plate much like corn. This planter bids fair to revolutionize methods of cotton planting. The cell-drop mechanism has a polished cell plate with sharp, hooked projections extending in the same direction that the plate is traveling. Above the cell plate is a retarding plate to prevent bunching of the seed, and above this an agitator plate which shakes and tears the seeds apart so that they will feed into the plate below. The cell plate is equipped with a cut-off, to insure greater accu-

racy. The cell drop is able to plant the cottonseed much thinner, thereby reducing the cost of seed and of thinning.

Cotton is also planted with the 2-row shoe type of planter, which is very much like an ordinary corn planter in appearance. These planters are commonly used when the land has been prepared in advance of the planting. The picker-wheel feed is used so far on these machines. They are interchangeable for corn by exchanging the cotton feed for corn plates.

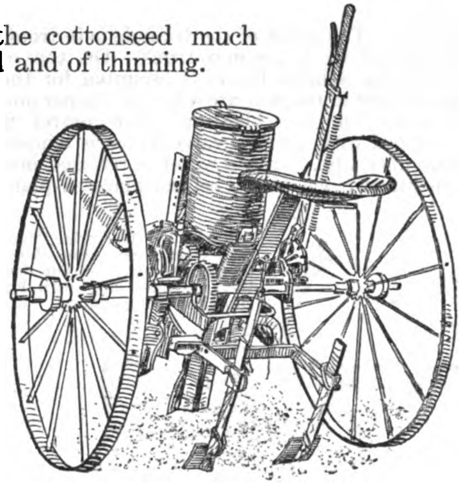


FIG. 139. Single-row, riding type cotton planter

**Peanut attachment.** Peanut attachments can be secured for most cotton and corn planters, either riding or walking type. The regular planter hopper is removed and the peanut hopper put in its stead. The nuts are taken out of the hopper by means of an endless-chain cup conveyor and dropped into the hose that leads to the furrow. Planting distances are controlled by the use of different sized sprockets which increase or diminish the speed of the conveyor.

**Listers.** A lister is a combination plow and planter, equipped with either corn or cotton plates. The plow is of the "middle-buster" type, that is, one having a double moldboard which in digging a trench throws the dirt both ways.

The middle-buster is set in a frame to which the planter box is attached. The whole implement must be strongly made and easily adjusted, to meet the adverse conditions under which it has to work. Both single- and 2-row types are made.

**Why listers are used.** Of more importance than the type of implement is the necessity for its use. Listing is a common practice in the central and southern portions of the Great Plains states. Where the annual rainfall is light, every method of conservation of moisture must be used.

Listed land is left with furrows and ridges at regular intervals. Land in this condition offers the best opportunity for rain to soak quickly into the subsoil, where it is protected from evaporation. Snow, also, is caught in the trenches and held far better than would be the case on an unbroken surface.

By planting in a furrow, weeds in the row are more easily killed; and as the furrows are filled the roots of the plants are left at a much greater depth than with surface planting. The crop stands dry weather better and is not so apt to blow down.

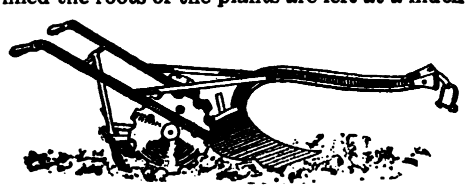


FIG. 138. Single-row, walking lister adapted to small scale corn or cotton planting

**Methods of listing.** Three methods of listing are used. Single listing is perhaps the most common. With this method the field to be planted is left untouched from the previous crop (except, perhaps, for the cutting of old stalks with a stalk cutter or disc) until the new crop is to be planted. Then the lister is put into the field and the seed planted in the furrows as they are made. The entire surface between the rows is covered with loose dirt, but a hard, unbroken ridge is left underneath. This method, while economical, should be used only on very deep, loose soils, if best results are to be expected.

Double listing differs from single listing in that the ground is listed twice. Usually the first job is done in the fall or in winter. At planting time the ridges are split and the seed is planted. This makes a better soil preparation, as all of the land has been stirred, more weeds are killed, and cultivation is easier.

Where land can be plowed either in fall or in winter and listed in the spring at planting time, better results can be secured than by either of the other methods. There is, however, a considerable increase in the labor cost. In thus preparing land the loose-ground lister is generally used. This machine is much the same as an ordinary corn planter, but is equipped with large double-disc furrow openers to form the trenches.

**TRANSPLANTERS.** Wherever tobacco, cabbage, strawberries, sweet potatoes, tomatoes, or other crops requiring transplanting are grown in commercial quantities, a transplanter is a labor saver and a money maker. The design of this machine is quite simple. It has a heavy triangular frame, low down, usually swung under the axle of the 2 main

wheels. The point of the triangle is in front, supported by a pivoted truck. On top of the frame a large barrel is mounted for the water, and in the rear are a furrow opener and 2 seats for the planters. The barrel is equipped with a water valve which is tripped automatically. As the water is released into the furrow, one of the setters places a plant

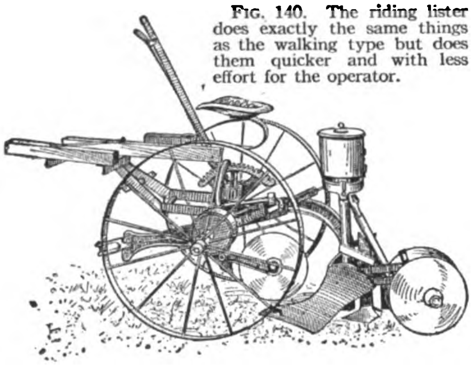


FIG. 140. The riding lister does exactly the same things as the walking type but does them quicker and with less effort for the operator.

in it, one man setting every other plant. The coverers pull the loose dirt around the plant, compacting it slightly in the process. Distances between discharges of water are regulated by the use of different sprocket wheels.

The use of water allows plants to be set in the heat of the day without wilting, which is impossible with hand setting.

POTATO PLANTERS. Improved potato machinery is causing a steady increase in the interest shown in this important crop. Outside of planting and harvesting, the labor required to produce a potato crop does not differ materially from that in the production of a corn crop. A large quantity of seed is required, ranging from 8 to 14 bushels per acre. This quantity is heavy and cumbersome and is in itself a discouragement to the man who would like to grow potatoes.

The modern potato planter has overcome most of the labor difficulties in planting. The seed can be cut by machine, and the planter will put the pieces in the ground with remarkable accuracy.

**How the potato planter works.** The planter is provided with a large hopper in which the seed is placed. In some planters, the seed runs by gravity into the picking chambers; in others, by a feed wheel which is practically a force feed. The latter construction prevents the flooding of the picking chamber, and makes far more accurate planting.

In the picking chamber the seed is caught on the point of sharp, revolving pickers and carried over to the spout leading to the furrow opener. Planting distances are controlled by the use of different sprockets that change the speed of the pickers.

The furrow opener should make only a narrow trench into which the seed is dropped and immediately covered. The double-disc type of coverer, set to throw in, is universally used. This not only covers the seed, but starts a good ridge. Where a slight ridge is raised at planting time, a harrow or weeder can be used before the potatoes are up and the weeds practically eliminated between hills in the row. The cultivator will take care of those between the rows.

**Single- and two-row styles.** Potato planters are made in both single- and 2-row styles. The 2-row planter is, of course, heavier to handle; but it decreases the labor cost of planting, and is just as efficient as the single-row machine. In addition, a 2-row cultivator can be used to tend the crop by following the 2 rows of the planter at all times. Otherwise, a 2-row cultivator cannot be used in the potato field.

## Drills

All small grain is now seeded in one of two ways—by drilling or by broadcasting with either an end-gate seeder or a broadcast seeder.

Practically all wheat, both spring- and fall-sown, is drilled in. The farmers have seemed to recognize the importance of using a drill to put in this crop. This is not so true, however, of oats and barley, particularly oats. In experiments conducted at various experiment stations, to determine the effect of drilling compared with broadcasting on the yield of oats, it has been found that a definite increase in yield can be secured by drilling instead of broadcasting. The Illinois Experiment Station secured, as a general average on 3 such fields for 3 years, an increase of 3.9 bushels per acre in favor of drilling. Kansas reports, after a long-continued experiment, an average increase of 5.3 bushels per acre in favor of drilling over broadcasting. The Ontario Agricultural College secured an increase of 4 bushels per acre as a result of drilling. Moreover, at the Iowa Experiment Station, a 4-year trial with winter wheat gave an average yield of 4.2 bushels more grain per acre for drilling as compared with broadcasting.

**Additional advantages of drilling.** Aside from the question of yield, there are the following advantages in drilling small grain: The seed is deposited in rows in firm, moist soil and covered at a uniform depth. An accurate amount of seed is distributed, less seed being required than in broadcasting. The ground is left with alternate small furrows and ridges. This favors the absorption of both heat and moisture, and gives some protection against drifting soil and winterkilling. Snow is held in the furrows to an appreciable degree.

Further, drilling is decidedly an advantage when clover or grass seed is to be sown with the grain. This work can be done at the same time the grain is seeded, thus saving labor. Owing to the more uniform stand and the unused space between the rows, the young seedling has a better chance to make a good stand than in broadcasted grain.

In sowing grass or clover seed in connection with a grain crop, one caution should be observed. Take the seed tubes off and let the seed broadcast ahead of the furrow openers. The dirt falling in together with the action of the drag chains will cover it sufficiently deep. Deep planting of small seeds is one of the main reasons for a poor stand. The seed fails to grow, or exhausts itself in pushing the young plant to the top of the ground. When using the drill for small seed alone, put the grain tubes on again, but set the furrow-openers to run very shallow.

**Styles of furrow openers.** From the farmer's standpoint, drills are usually classified according to the kind of furrow openers with which they are equipped. There are 5 kinds of furrow openers in use in various sections of the country, namely: hoe, shoe, single-disc, double-disc, and combination shoe and double-disc, commonly called the "open-furrow" type.

**Hoe furrow openers.** The hoe furrow opener was found on the early drills and is still popular in many localities. It does excellent work in a clean, well-prepared seed-bed. The hoe drill is at a disadvantage in trashy ground or where grain is to be drilled in stalk land that has only been disked. The delay caused by loading up has practically eliminated the hoe drill from this class of work.

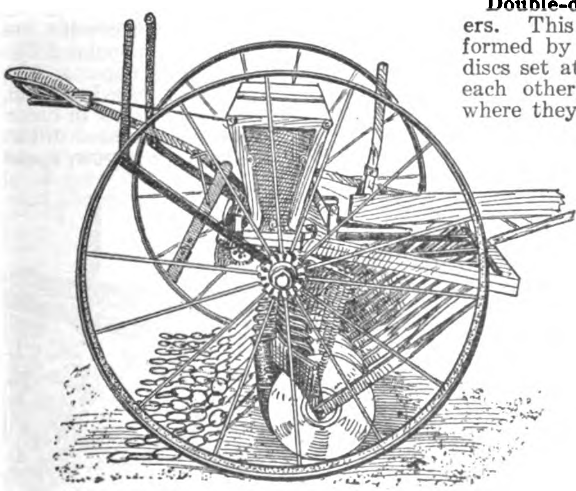


FIG. 141. Grain drill of the single-disc type with drag chains for covering the furrows

One of the recent practical improvements in the hoe furrow opener is the attachment to each hoe of a spring trip. When any hoe hits an obstruction, it trips without breakage of any parts and swings back into working position.

**Shoe furrow openers.** The shoe furrow opener looks much like the ordinary corn planter shoe. This type of furrow opener, also, does excellent work in a clean, well-prepared seedbed. With the shoe, the depth of seeding can be very accurately adjusted, which makes it most desirable when seeding in alfalfa or other small seeds. In trashy ground or in stalk land, the shoes also load up, making them undesirable for this class of work.

**Single-disc furrow openers.** The single-disc furrow opener is by far the most popular type, serving the purposes of good seeding in the greatest variety of soil condition. Since half of the discs in the drill are set to throw in one direction and half in the other, this type of furrow opener has a decided cultivating effect that farmers have not been slow to appreciate. The single-disc drill will do good work in any type of soil that is not too stony, and it cuts through trash and corn stalks in an excellent manner.

The forward delivery of seed is an important improvement for the single-disc furrow opener. In the open-delivery style of disc furrow opener, the seed does not reach the bottom of the furrow before the upturn of the revolving disc catches it; thus the seed is often thrown on top of the ground. In the forward delivery the seed reaches the ground before the upturn of that section of the disc sets in and is consequently well covered.

**Double-disc furrow openers.** This furrow opener is formed by two straight, flat discs set at an angle toward each other, coming together where they enter the ground. This type of furrow opener is used extensively in heavy wheat lands of the Northwest. The double-disc has practically no cultivating action, but cuts through the soil like a shoe opener without turning it and without the consequent loss of moisture.

It also has an added advantage over the shoe

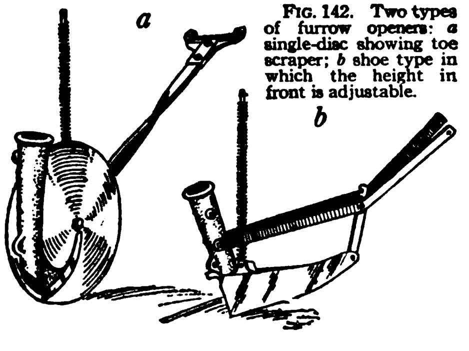


FIG. 142. Two types of furrow openers: *a* single-disc showing toe scraper; *b* shoe type in which the height in front is adjustable.

opener in that it will go through trash or stalks without clogging. In fact, it is practically impossible to load up a drill of this type, but the double discs do not cut through trash as well as the single-discs and under such conditions will not cover the seed quite as well.

**Combination shoe and double-disc furrow openers.** In this style of opener, the shoe is set between two concave discs and makes the first cut of the furrow. The discs are set at equal but opposite angles, and they throw the soil to each side, leaving a wide furrow from 2 to 6 inches deep, as desired. The dirt in the ridges on either side of the furrow gradually sifts back during the winter and spring until the land is nearly level again.

This style of furrow opener is made especially for the South for seeding winter oats and other small grain. The openers are from 14 to 16 inches apart and are often equipped with double seed spouts. This is especially desirable for winter oats, as they are invariably bearded, and do not feed through as rapidly as they should, to make a good stand, if a single-grain tube is used.

**Force feed.** There are two general types of force feed employed in grain-drill construction, the fluted-roll and upright-revolving-disc. The fluted rolls are attached on 1 long drill-shaft, and each roll is fitted inside a feed cup. The feed cups are usually fitted with an adjustable gate, which may be opened or closed for various kinds of seeds. The rate of seeding is controlled by a movable cut-off operated by a hand lever. This lever is set to act as a pointer for the scale which indicates the amount of seed being used. In the upright-revolving-disc type of force feed, the disc is placed at the side of the feed cup. Projections on the discs force the seed grain into the grain tubes. The rate of seeding is generally controlled by increasing or decreasing the speed of the discs.

Of the 2 types, the fluted-roll is the more popular and is used on the majority of drills now being manufactured.

**Standardizing the drill.** There is a wide variation in the size of seeds of the same kind, due to the variety, season, and soil fertility. For instance, a kernel of Kherson oats is little more than half as big as one of Swedish Select. It is obvious, therefore, that a drill set to sow 8 pecks of large-berried oats will sow more than that amount of the small-berried kind.

The gauge or scale on a drill cannot be considered as more than an index. If correct seeding is desired, the drill should be checked up each year. For all practical purposes, the easiest way to do this is to measure into the machine the correct amount of seed per acre it is desired to sow. Set the drill for this amount, and drive ahead until the seed has been run out. Usually, the length of the field in rods is well known; the width sown can easily be measured. Multiply the length in rods by the width in rods, and divide by 160. This will give the area in acres or fraction thereof. If too little seed is being used, open up the drill; if too much, close the cut-off.

The condition of the grain at the time of seeding will also have considerable effect on the amount that will go through—whether it has been thoroughly recleaned, is absolutely free from chaff and trash, or whether these latter impurities are present. It should be especially noted that grain treated for smut with formaldehyde or hot water will swell considerably. This will affect the amount of grain put through to such an extent that in the latter case a standardizing of the drill similar to that described above will be essential.

**Distance between furrow openers.** There has been a distinct tendency in the last few years to close up the space between the furrow openers. Wide spacing gives weeds a better chance, and the seeds must be thicker in the row to sow the same amount per acre. This means crowding of plants, and it stands to reason that the grain will not do so well as when better spaced.

The most popular drills are now spaced only 6 or 7 inches apart. This close spacing has greatly increased the danger of clogging with stalks or trash. In order to offset this, most of the close-spaced drills are set zigzag, with every other furrow, opener set several inches

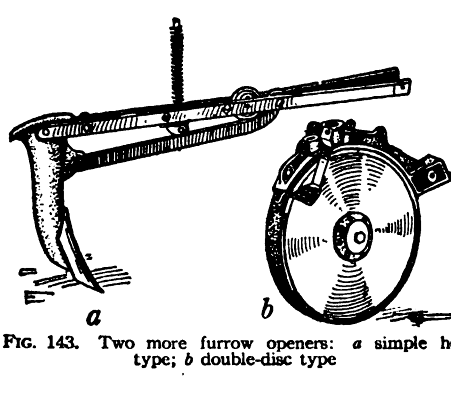



FIG. 143. Two more furrow openers: *a* simple hoe type; *b* double-disc type

ahead of those next to it. This in reality makes 2 rows of furrow openers.

Some manufacturers have gone so far as to set 2 drills in the same frame, so constructed that the back set of furrow openers split the middle left by the front ones. This makes very close spacing. The idea is excellent, but the machine is so cumbersome that it is not yet an unmixed success.

**Fertilizer attachments.** The fertilizer attachment for a grain drill is a secondary box next to the seed box, equipped with a force-feed device and spouts leading to the furrow openers. Owing to the fact that some fertilizers will "bridge," it is necessary to equip the fertilizer box with an agitator, to keep the material down to the force feed. The flat-disc type of force feed is the one in most common use. It gives positive results with a minimum of breakage.

**Press drills.** Press drills are made without supporting side wheels, but, following each furrow opener, there is a press wheel. This row of wheels is fastened on a long axle and set in a frame which in part supports the drill proper. Press-wheel attachments can also be secured for most types of grain drills. This equipment is used in sections where high winds blow the soil and seed badly and on light soils where compacting the dirt over the seed brings up the moisture and hastens germination.

**The clover-and-grass-seed drill.** The latest thing in seeding machinery for sowing clover, alfalfa, and grass seed is what is known as the clover-and-grass-seed drill. This machine is designed especially for sowing these seeds. It is built so that the seed is sown in furrows 4 inches apart, which is about the proper distance for a good stand. Another advantage of using this drill is that it permits the cultivation of the grain already above the ground and thereby tends to increase the yield.

The common practice is to sow 1 bushel of clover seed to 7 or 8 acres and 18 to 20 pounds of alfalfa to 1 acre. This is by the broadcast method. It is claimed and proved by tests that, with a clover-and-grass seeder, from 4 to 6 pounds of seed may be sown per acre, and that the stand will equal, if not surpass, that obtained by broadcasting from 2 to 5 times this amount of seed.

In 1 pound there are about 240,000 alfalfa seeds and 288,000 clover seeds. Since there are 43,560 square feet in an acre, then for every pound of alfalfa sown per acre there will be an average of 5½ seeds per square foot, and for every pound of clover there will be 6½ seeds per square foot. Farmers have been known to sow (broadcast) as high as 25 pounds of alfalfa to the acre. This is at the rate of 137 seeds per square foot, and no ground will support such a stand, if all the seeds grow. The Ohio Experiment Station found that 5 pounds of alfalfa seed, sown on an acre by a clover-and-grass-seed drill, gave a yield of 7,862 pounds of hay, and that 25 pounds, sown broadcast on the same acreage, gave a yield of 7,876 pounds of hay.

By the use of this drill the farmer is enabled to put the seed down in the moist earth at the right depth, where it germinates quickly. In this way, practically all the seed grows, and the tremendous loss resulting from broadcasting methods is eliminated.

The main disadvantages of the clover-and-grass-seed drill are that it means the purchase of extra equipment, and, where the seed is put in with spring-sown grain, the land must be drilled over again for the small seed alone. The value of saving seed and the better chances of securing a stand must then be weighed against increased labor and machinery costs. This is an individual problem.

**One-horse drill.** The 1-horse drill is the same in principle as the larger types just described, and it may be equipped with practically all the attachments. This type of drill is generally built with 5 furrow openers of either the hoe or the disc style. The advantages and disadvantages of each are the same with this drill as previously described. A drill with 3 furrow openers is also built for Southern use, where small grain is to be drilled between cotton or corn rows.

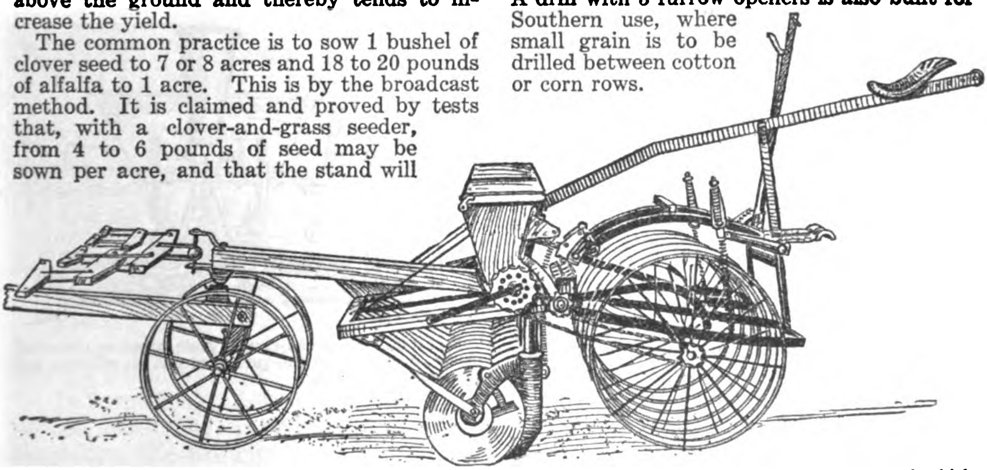
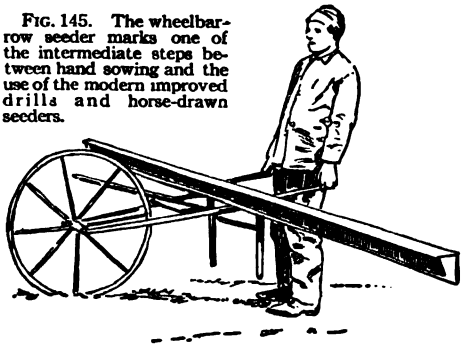


FIG. 144. Press drill. Note absence of regular wheels, their place being taken by the narrow ones, each of which firms the soil behind a furrow opener

FIG. 145. The wheelbarrow seeder marks one of the intermediate steps between hand sowing and the use of the modern improved drills and horse-drawn seeders.



When drilling winter wheat or rye in standing corn, the drill should be run across the ridges, that is, in the opposite direction to that in which the corn was laid by. Otherwise, the outside furrow openers will go too deep and the middle ones too shallow. The matter of cross drilling should also receive careful consideration. In cross drilling, one half of the seed is sown when going one way; the other half, when crossing. This means twice the work but eliminates the unseeded portion left where the row of corn stood. In addition, the seedbed is put in much better condition. Since no previous preparation has been made, this extra work can well be afforded.

**Broadcast seeders.** Broadcast seeders are very similar to grain drills, so far as the seed-box and force-feed equipment is concerned. The seed, however, falls directly to the ground from the seed cups, and must be covered by other agencies. Some broadcasters are equipped with a cultivator attachment, which may be of either the shovel or the disc type. In the corn belt, however, farmers who broadcast their small grain prefer to work their land more thoroughly with disc harrows, so that if a broadcaster is used, it is merely for the purpose of distributing seed.

A good broadcaster must have a large, well-braced grain box. Sagging is very undesirable. The broadcaster is built in two styles: the wide-tread, having a wheel at each end, and the narrow-tread, in which the wheels are close together and the grain box extends beyond each wheel. There is practically no chance of sagging in the latter type.

**End-gate seeders.** The end-gate seeder is in common use throughout the corn belt particularly. It is used primarily for seeding oats, although wheat, barley, and rye are often sown broadcast with it.

In spite of data at hand showing the possibilities of increased production by drilling over broadcasting, the latter practice is by far the more common in nearly all parts of the corn belt. This is probably due to several factors. An end-gate seeder can be bought for less than one-fifth the price of a 4-horse drill. Seeding can be done considerably faster. Most farmers regard oats as a crop of secondary importance, and wish to get seeding out of the way as quickly as possible, in order to start work on their corn land.

The ordinary end-gate seeder is bolted on to a board that replaces the back end gate of the wagon, and is driven with a chain that extends from a big sprocket, bolted to one wagon wheel, up to the drive shaft of the seeder.

The grain is shoveled from the wagon into a large hopper, and delivered thence by a force feed into the distributing fans. The fluted-roll type of force feed, described above, is commonly used. An auger construction is also used to deliver the grain to the fans. Both types are efficient.

Double fans are now used in practically all end-gate seeders. They are set side by side, and run in opposite directions, both throwing away from the machine.

A clover-and-grass-seed attachment can be provided in the shape of a small extra hopper with seed spouts running down to the fans. This attachment can be operated either at the same time grain is being seeded or alone. Where clover or grass seed is put in with the small grain, it will rarely carry as far as the grain; consequently, bare streaks are left.

It is also not the best practice to disc down small seeds, as they may be covered too deep to germinate well. If the end-gate seeder is to be used, it is better practice to sow the grain; after this is disked in, sow the small seed and follow with a drag harrow or corrugated roller.

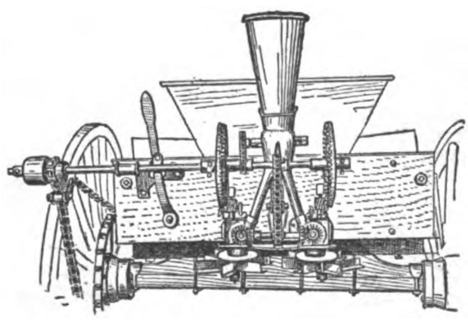


FIG. 146. For broad-casting grain, grass, or grass and clover mixtures, the end-gate seeder is an efficient and economical machine.

# CHAPTER 9

# Machines for Harvesting and Threshing Crops

*By* F. H. DEMAREE *(see Chapter 7). In discussing plans for this chapter, Professor Demaree said: "It has been my privilege to have operated or worked with most of the implements described in this chapter. Here in Grundy County there is a growing interest in sweet clover. In the spring of the second year of its growth, the first cutting of this crop must be very high or the entire crop may be killed. Many plans were tried to hold the mower bar up to the desired height, until finally the plan described in this chapter was worked out. It has been uniformly successful.*

*"The seed-saving device is not original, but I have shown a number of farmers how to make the outfit which is an exceedingly valuable attachment when the binder is used to cut sweet clover. Many bushels of ripe unhulled seed will be saved in cutting even a small field.*

*"After having run one binder machine for 10 consecutive seasons, I can realize that it is an important and complicated machine. Mine is now 16 years old and still in use. Proper care, including housing, regular oiling, and keeping all parts tightened up, are all responsible for the long life this machine has enjoyed. My grandfather always said that oil was cheaper than machinery. I might add that a monkey wrench and a little time spent in tightening up nuts and bearings are both cheaper than a smash-up." It is practical knowledge such as this that counts whatever the type of farming and wherever it may be attempted.*—EDITOR.

NO CROP can show a profit until it is finally marketed or utilized. The size of the profit (or loss) at that time depends on a good many factors, none of which is more important than the combined speed, thoroughness, and economy with which it is gathered. In this light, the tools with which this harvesting work is done, and their proper attention and handling, assume a correspondingly vital importance.

**The mower.** Owing to its labor-saving ability, the mower is an indispensable implement on practically every farm. It is not only used in the meadows at haying time, but it trims the roadsides, the pastures in the fall, and in a number of ways helps to avoid hand scything.

Taking everything into consideration, the mower, in spite of its usefulness, is not a very heavy-duty machine and should, if properly cared for, be made to last for a much longer period than the average farm tool.

In running a mower through heavy grass or clover, there is considerable strain on the sickle bar, as well as on the driving mechanism. When buying a mower, therefore, the principal features to take into consideration are strength of construction, fewness of gears with as direct drive as possible, and the necessary adjustments to keep the sickle bar in alignment.

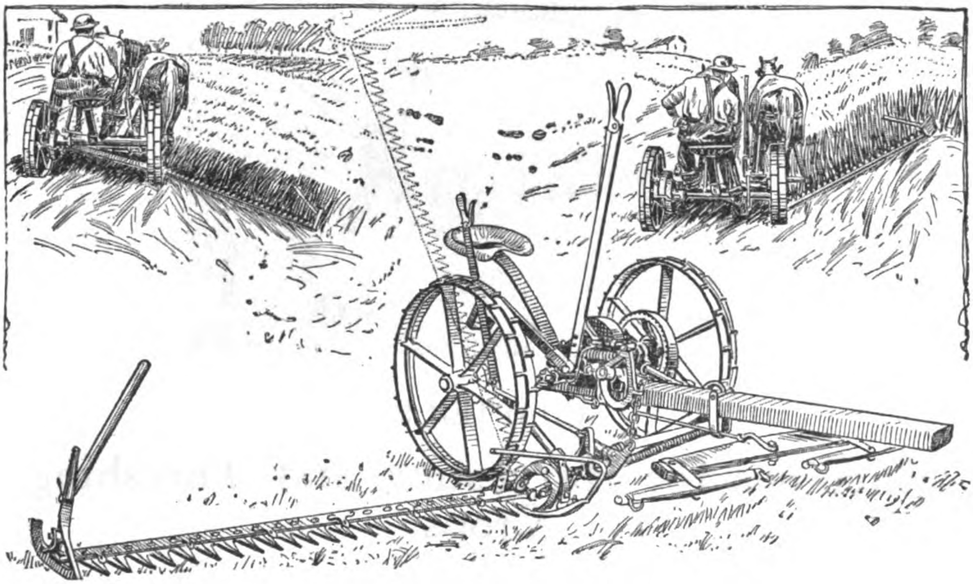


FIG. 147. A modern, high-class vertical lift mower, the dotted lines showing the position of the sickle bar when raised and the insets showing how it may be adjusted to cut on sloping ground

**Vertical or plain lift.** The ordinary or plain lift allows the operator with foot lift or hand lever to lift the sickle bar several inches from the ground. This is for use in turning or transporting the mower short distances.

The vertical lift allows the operator to bring the sickle bar to an upright position without stopping the team. This feature is especially good when the mower is to be used in stumpy or stony land or where any obstruction more than a few inches in height must be passed. It will not only make the work easier, but will allow a much cleaner job of mowing.

**High clipping.** Where it is desired to clip higher than the ordinary set of the mower will allow, shoe runners can be used to raise the blades. In practically all shoe runners, the lower part is held in position by an upright piece of strap iron near the heel of the runner. This should have more than one hole in it; when fully extended it will raise the sickle bar considerably.

Sweet clover is a crop requiring very high clipping in the spring. The usual range is between 8 and 10 inches. For such work, it will be necessary to displace the short piece of strap iron just mentioned for one long enough to raise the shoe to the desired height. This adjustment should always be made when clipping the first crop of sweet clover. If it is not clipped high, the plants will be killed; and if the attempt is made to raise the sickle bar with the hand lever, without the support of the shoes, the weight of the sweet clover will probably spring the bar.

**Bunchers.** Two types of buncher attachments for mowers are in use for cutting clover seed—the side-delivery and the rear-delivery. The side-delivery buncher delivers the seed behind the mower, so that it is never tramped on by the horses or run over by the machine. The seed is delivered in long rolls; and it is harder to turn or load for threshing than the flat bunches of the rear delivery.

The rear-delivery buncher is simply a large iron basket attached to the sickle bar. It has a foot trip, and can be dumped when full. The seed is delivered immediately behind the sickle bar, and the team and machine must pass over it the next round. If the clover is heavy, some of the seed will be shattered by such contact. Ease of handling the seed after being cut is the strong point of this type of buncher.

**The dump rake.** The dump, or sulky, rake is nearly universal in the hayfield. It is light, easy to operate, inexpensive, and can be used almost anywhere where a horse can be driven.

This rake may be either of the hand or of the self-dump type. In the latter type, a foot trip in front of the driver is given a push which causes a cam in each wheel to engage in a ratchet, thus bringing up the teeth.

The sulky rake does not leave the windrows in good condition for the use of a hay loader. Besides, if it becomes slightly overloaded between dumps, as it will in extra-heavy hay, it will not carry the load. This means hay strung along between the windrows, that is hard to pick up or must be reraked. The windrows themselves, too, are apt to be

stringy, as it is nearly impossible to get the teeth down quickly enough to make a clean-cut windrow, especially where using a fast-walking team.

**The side-delivery rake.** The side-delivery rake is rapidly supplanting the dump rake where hay is grown in quantity and where quality is desired. It is now conceded that the way to make the best quality of hay is to follow the mower, either directly or within a few hours, with a side-delivery rake. This puts the hay in long, narrow windrows, protecting the leaves from the sun, and thereby aiding the evaporation of water from the stems. This will mean somewhat slower curing; but, on the other hand, the leaves will be retained, and the hay will all be soft and pliable, rather than harsh and sun-baked, as it is when exposed to the sun too long.

Side-delivery rakes are made in 2 general styles—the fork type and the cylinder, or reel, type. The fork-type rakes are made by attaching the raking forks to a crankshaft driven from the axle. The forks work in rotation, and move the hay out of the swath to one side, forming the windrow.

The cylinder- or reel-type side rakes have the teeth attached to long bars arranged in cylinder fashion. The cylinder is set diagonally in the frame and is driven from the main axle. The teeth on the various bars that form the cylinder are in constant touch with the hay, as the cylinder revolves, so that it is swept to one side with the least shattering.

Some cylinder and fork type side-delivery rakes may be make into tedders by shifting a gear. The hay is merely stirred by the rake teeth, in order that it may dry out better before raking. It is questionable whether this is as good practice as to turn the windrow with the side delivery to hasten curing, if this seems necessary.

**The sweep rake.** When hay is to be stacked in the field, the most economical way to handle it is with a sweep rake and stacker. This type of rake has a set of long wooden teeth, mounted in a frame, and can be raised or lowered. The frame is supported by 2 forward wheels and either 1 or 2 rear wheels. The team is hitched to the rear of the rake, either directly or to one side, and pushes it forward. The hay may be gathered out of the windrow or the swath, but usually out of the windrow. When working, the operator lowers the teeth to the ground and drives ahead. The teeth slip under the hay gathering a load. When no more hay will stay on, the teeth are raised and the load driven to the stack. Then the teeth are again lowered and the team backed out.

The use of the sweep rake is typically Western; but it is rapidly finding favor over the whole country, where hay is put in stacks in the field.

**Hay tedders.** The hay tedder is a 2-wheeled machine with the tedding forks directly in the rear. These forks are clamped to a crankshaft, and work in rotation with a backward kick as each fork begins to rise. This picks the hay out of the swath, so that air can circulate freely through it, thus hastening curing. If a dump rake is to be used for windrowing, the hay tedder, run ahead of the rake a few hours, will improve the quality of the hay. With a side-delivery rake, the tedder is rarely needed except after rains.

**Hay loaders.** Like the side-delivery rakes, hay loaders are

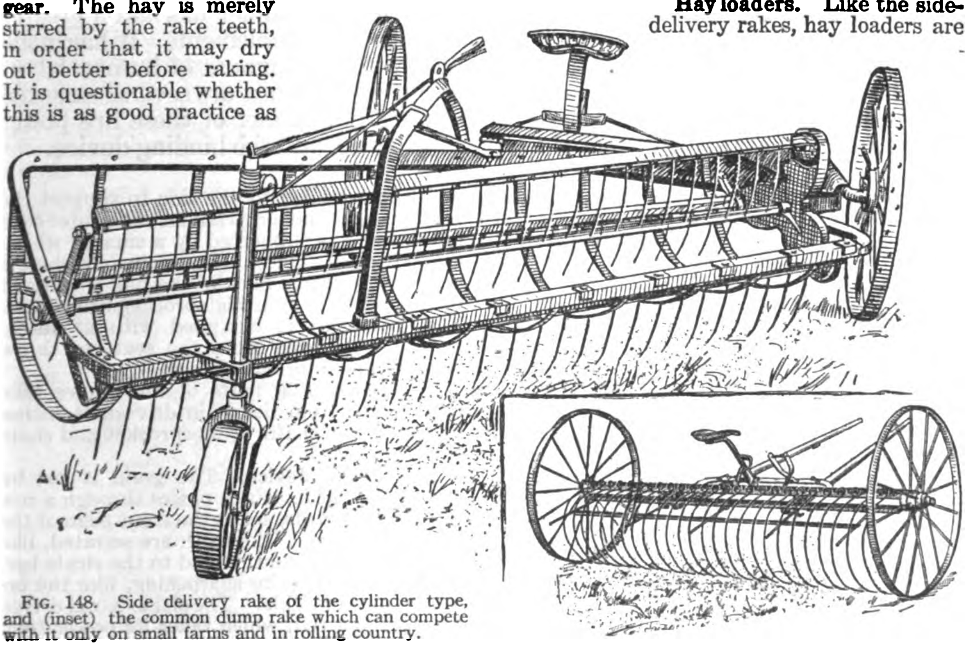


FIG. 148. Side delivery rake of the cylinder type, and (inset) the common dump rake which can compete with it only on small farms and in rolling country.

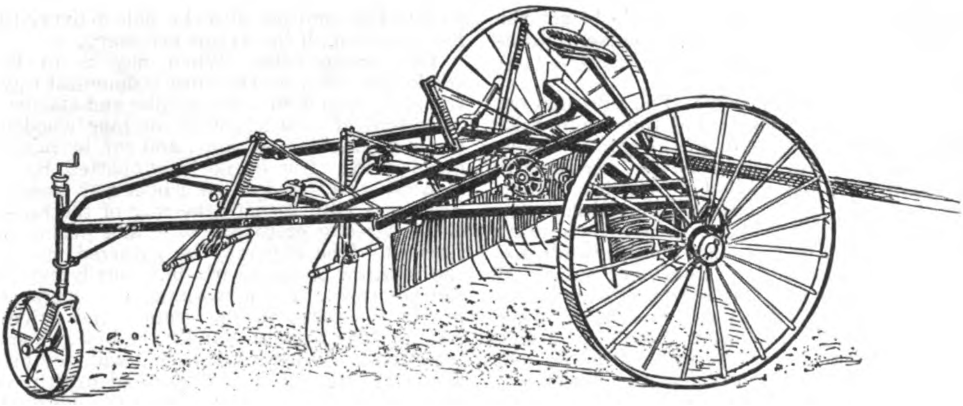


FIG. 149. Side-delivery rake of the fork type. Being likely to cause more shattering, this is better for grass than for leguminous hays

made in both raking fork and cylinder styles. In the first style, the fork bars are attached either to crooked crankshafts or rock shafts that give the forks a straight backward and forward movement. As the hay is pulled forward into the loader, it is caught by the conveyors and carried to the wagon.

The cylinder- or drum-type loaders are made with wire teeth attached to bars forming the cylinder. The drum is driven from the main axle and revolves continuously, lifting the hay on to the carriers or conveyors. The carriers may be either of the push-bar or slatted types. Both are efficient in delivering the load to the wagon.

Both the fork- and drum-type loaders are made to take the hay out of the swath or windrow, and both do good work. There is a growing tendency to use the windrow loader, owing to the better quality of hay made by windrowing it soon after being cut. These two types of loaders are in general use and favor.

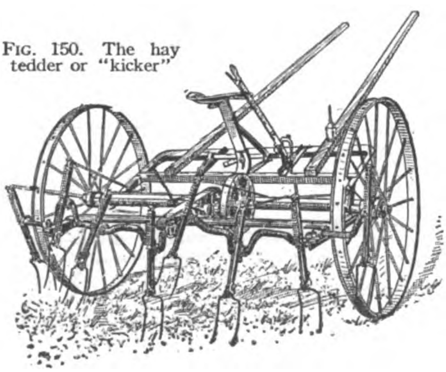
## Small-grain Harvesters

**The grain binder.** Aside from the plow, the grain binder has had a greater share in agricultural development than any other farm implement. It has made possible the harvesting of large areas of grain with a minimum of human labor.

The binder is a complicated piece of machinery, but there are several essential points of construction that deserve special mention. Chief of these are power transmission, the cutting device, the elevating device, and the binding device.

**Power transmission.** The grain binder has one large drivewheel, or bull wheel, as it is called. This wheel is set in a strong frame, which is extended to one side to support the platform and platform canvas. The outer edge of the frame is supported by a smaller wheel, called the grain wheel. The main driveshaft is set into the frame back of the bull wheel and connected to it by a big sprocket drivechain. The driveshaft is equipped with a clutch, which is operated from the seat, to throw the machine in or out of gear.

FIG. 150. The hay tedder or "kicker"



All the running parts of the binder take their power from the main driveshaft, either by cog-driven shafts or by sprocket and chain gearing.

**The cutting device.** The grain is cut by means of a sickle, which passes through a row of pointed guards, set in the front edge of the platform frame. The teeth are serrated, like an ordinary file, and riveted to the sickle bar. They do not require sharpening, like the ordinary mower sickle. The sickle bar is driven by a pitman rod, which takes its power from

the main driveshaft by means of a secondary shaft extended forward along the side of the frame and cog-driven.

Although not a part of the actual cutting device, the reel is used to aid this function. The reel has 2 important lever adjustments, one to raise and lower it, and the other to move it forward or back. Any one driving a binder should pay a great deal of attention to the reel. By lowering it, grain that is very short can be cut that would otherwise bend before the sickle and never be harvested. Tall grain should be cut with a high reel, in order to avoid straw wrapping around it and to avoid throwing the straw so far back on the platform canvas that it will not be properly elevated or properly bound.

Again, in cutting short grain, the reel should be carried well back, as well as low down, in order that the grain may be swept into the sickle and a clean job of cutting done. This, also, causes the short-strawed grain to fall farther back on the canvas, and aids in proper elevation to the packers. If the reel is not carried in this manner, short straw will have a tendency to fall close to the sickle bar, head first. It is practically impossible to make a good bundle when this occurs.

Just the reverse is true when cutting long-strawed grain. Carry the reel high and forward. If it is swept too far back on the platform canvas, it will be elevated in the same relative position and bound too close to the butt of the bundles. Such bundles will be hard to shock and will take water badly.

**The elevating device.** The ordinary grain binder has 2 elevating canvases with which to deliver the straw to the packers. The platform canvas runs the full length of the binder platform, which varies from 5 to 8 feet in length. This canvas is driven by 2 rollers, 1 at each end of the platform. Its movement is toward the body of the machine, where the straw is delivered to the elevating canvases.

There are 2 elevating canvases, set at an angle of about 90 degrees, one above the other. These canvases are worked by rollers, the same as the platform canvas. The lower roller of the bottom elevator canvas is close to the inside roller of the platform canvas, which allows the grain to feed up on to the elevator. The 2 elevators run in opposite directions, thus between them lifting the grain and delivering it directly to a sheet-iron sloping platform, where the packers feed it into the binding device.

**The binding device.** The packers are curved iron fingers working on a crooked crankshaft which gives them a forward and backward movement, lowering each packer as it moves back, and raising it as it comes forward.

The grain is pulled forward until it is in position on a steel spring trip, where it is held by an iron upright. As more grain is fed forward, the weight on the trip increases until the spring is tripped. At this point a large iron needle comes forward, carrying the twine. This is passed over the bundle, the knot is tied, and the twine cut, all in one operation. At this point, the binder head is so timed that it starts to revolve, and the long iron fingers or rods push the bundle on to the bundle carrier.

A good bundle should be tied around the middle or slightly above the middle. Two adjustments must be watched by the operator. The butter board, which keeps forcing the butt ends of the straw into place, can be moved backward and forward, and has a great deal to do with the place at which the bundle is tied. In addition to this, the binder head can be shifted back and forth by a hand lever. When shifted forward, the bundles will be bound closer to the heads; when shifted back, they will be bound nearer the butts. This shift is a necessary one to watch, if a good job of binding is to be done.

Do not oil the knotter jaws. If they are tight or rusty, loosen them up with kerosene before starting. After that, the twine will keep them polished. Oil causes dust to settle on them, and also allows the twine to slip off too easily. If the bundles are not tied, the knotter jaws may be either too tight or too loose; there is a spring tension adjustment for this. Or the trouble may be in the tension of the twine at the box, or in an improperly threaded needle. Be sure the twine goes through all the little eyes before reaching the needle provided for it.

**Grain and seed savers.** When cutting some crops, especially over-ripe ones with a binder, there is more or less shattering of seed. This is particularly true of sweet clover. In order to save

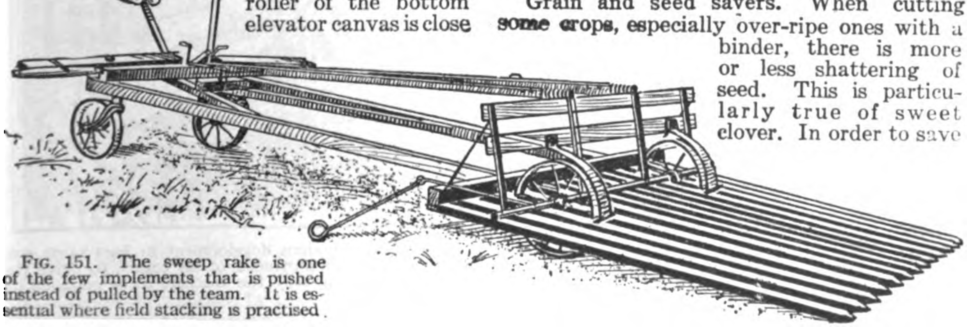


FIG. 151. The sweep rake is one of the few implements that is pushed instead of pulled by the team. It is essential where field stacking is practised.

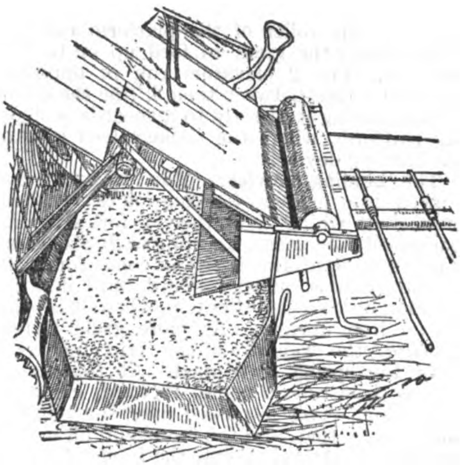


FIG. 151. Front view of grain saver or binder. Front end of pan is unhooked and let down

this seed, it is necessary to catch it at the points at which it will fall from the binder to the ground. There are 2 main points to be protected—under the packers and between the platform canvas and the elevator canvas.

A grain-saving device attachable to a binder is now on the market; but, if a farmer is so minded, he may make a good one himself at small cost. The materials and special tools needed are: three 3 by 8 foot pieces of galvanized iron, 3 dozen 1 by $\frac{3}{16}$ inch stove bolts, a vise, iron drill, snip shears, 3 dozen iron rivets, about 30 feet of $1\frac{1}{2}$-inch strap iron; and a hack saw or other instrument for cutting iron.

There are 2 main pans or troughs. One is attached between the platform and bull wheel, fastened to an angle iron on the under edge of the platform, just beneath the lower roller of the elevator canvas, and to the frame of the binder next to the bull wheel. The other trough is attached under the packers, between the bundle carrier and bull wheel, and fastened to the binder frame and to the bundle-carrier bolts.

Two iron straps are used for each trough. Have the troughs extend the full width of the machine, with sloping ends. In cutting tin, be sure to make an allowance of 10 inches or more for each end. One end should be sloping to such a degree that seed may be raked out easily. The pans are fastened to straps, which, in turn, are fastened to the binder. Stove bolts may be used for doing this.

Straps for fastening the troughs to the machine should be cut so that they will be 36 inches long, exclusive of end fastenings. The bottom of each trough should be about 9 inches wide, and the sides about 12 and 15 inches. The sides should be bent at an angle of 45 degrees. Of course, these measurements will vary with different machines.

An apron should be placed under the elevator canvas, attached to and a few inches under the top edge of the packer table, hanging out over the platform trough. The lower end hangs loose, resting on brace irons. It should be the full width of the binder. A strip of tin should be placed under the lower edge of the packer boards, extending a few inches out, and sloping back over the bundle-carrier trough. This should be an inch or two longer than the width of the machine, curving in, so that all material will run into the trough. Extension tins are placed on the back side of the binder, running from the lower edge of the elevating canvas, up under the seat, and over the top roller cogs, down along the edge of the packer table, connecting with a strip under the latter. At the end of the packer table, this extension tin should be curved in, so that it will funnel over and into the back trough.

**The small-grain header** is built on the same general lines as an ordinary binder except that the platform can be carried very high, so as to clip off only the heads of the grain with a very small section of straw. This machine is pushed ahead of the team, to avoid running down the grain, and to simplify construction. The reel sweeps the grain directly on to the platform canvas, which delivers it to an elevator that extends upward from the side of the machine to reach a grain rack that is driven alongside. A combination or inter-changeable header and binder is also on the market.

Where the ordinary header is used, the grain must be well matured at the time of cutting. It is taken directly from the machine and built into large stacks, to stand until threshing. This practice can only be followed in the drier sections of the Great Plains and Pacific Coast regions, where the rainfall is sufficiently light to allow it. A still larger combination header and thresher is sometimes used, which not only heads the grain, but threshes and sacks it at the same time.

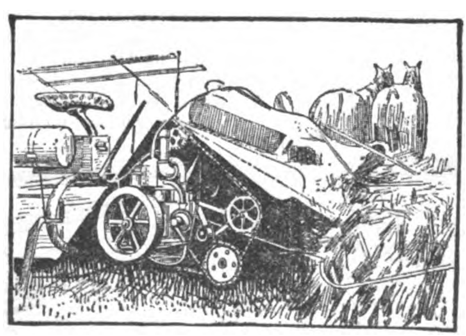
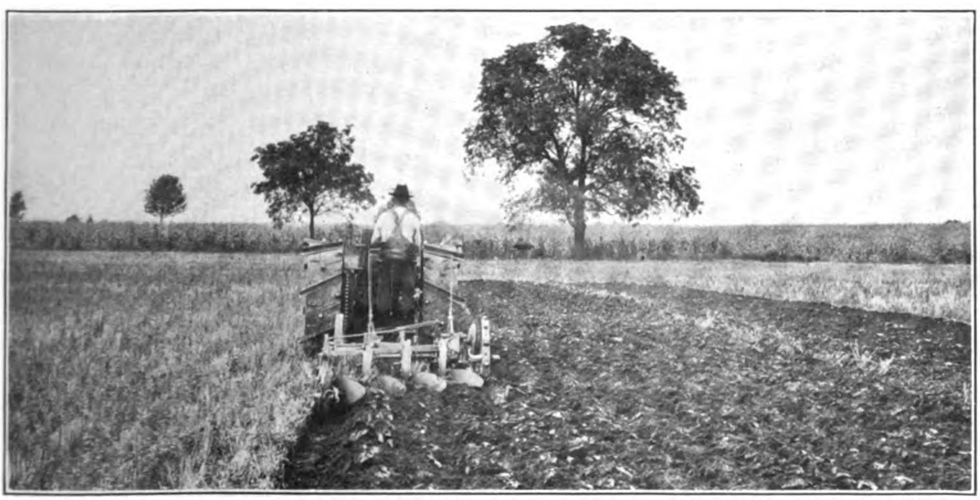


FIG. 152. A modern development in harvesting machinery is the employment of an engine to drive the machinery, leaving only the traction to be supplied by the team

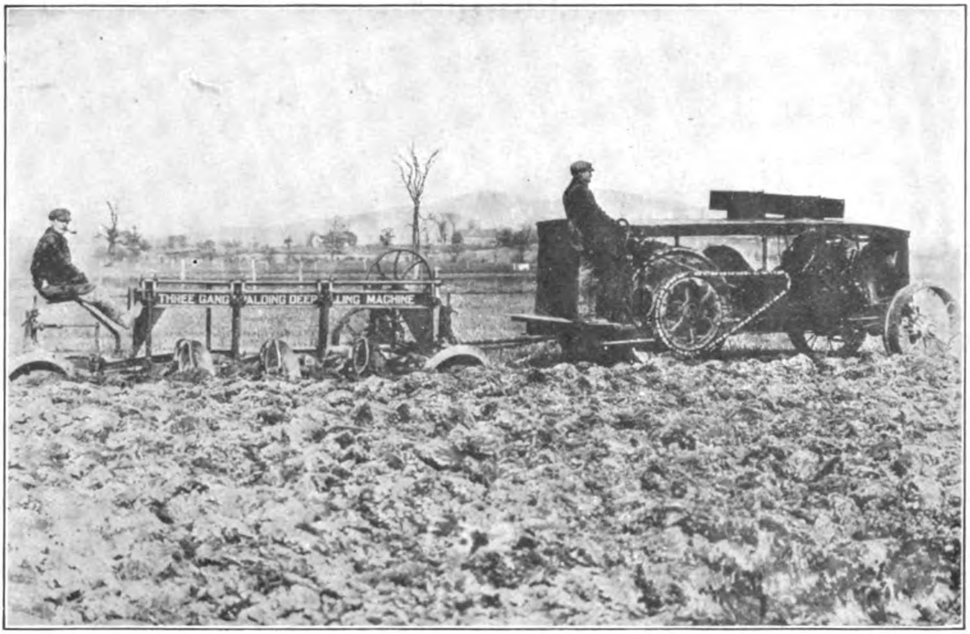
Results: small in amount, poor to medium in quality

Results: good and moderately large, but measured after all by the physical limitations of the animal body

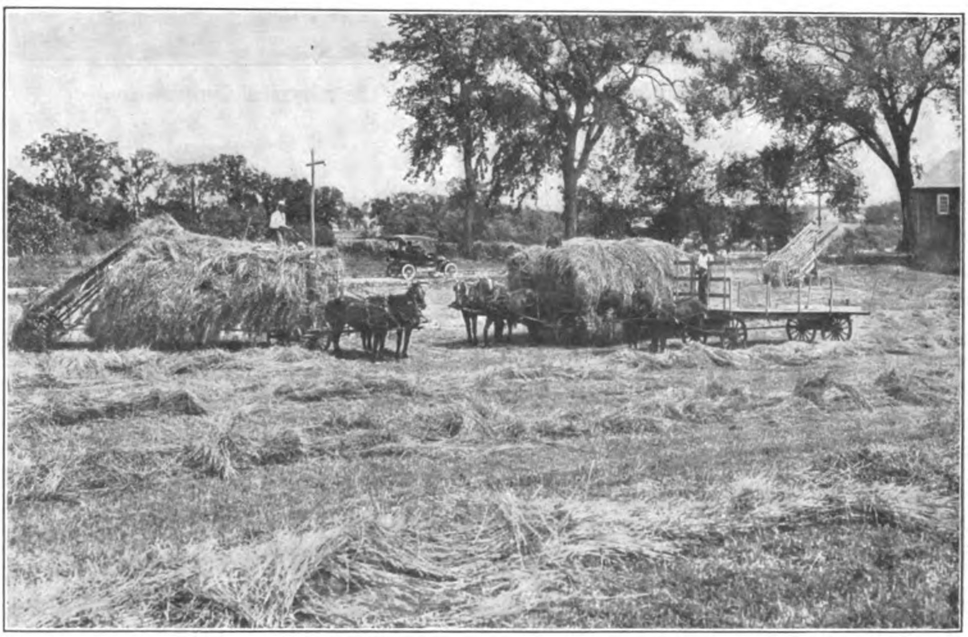


Results: excellent, limited only by the restrictions imposed by nature upon the operator

THE PROGRESS OF FARMING IS MARKED NOT ONLY BY THE INCREASED AMOUNT OF WORK DONE, BUT ALSO BY THE GREATER EASE WITH WHICH IT IS ACCOMPLISHED




Where conditions are right the deep-tilling machine (in this case of the disc type) does a work that can be done in no other way



Because haying is so nearly a universal farm practice, improved hay-harvesting machinery is among the most valuable of modern agricultural inventions

THE OBJECT OF A FARM MACHINE IS TO SAVE TIME, SAVE LABOR, INCREASE THE WORK DONE AND DECREASE ITS COST. DO YOUR IMPLEMENTS DO THIS?

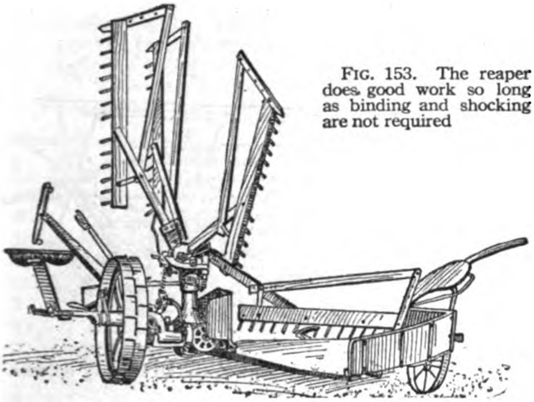


FIG. 153. The reaper does good work so long as binding and shocking are not required

**The reaper or self-rake.** This machine is designed to meet the needs of farmers who prefer to leave grain in gavels (small bunches) on the ground, rather than to bind and shock it. For such crops as flax, buckwheat, and clover seed the implement is ideal; but it is doubtful whether it should ever be used in place of the grain binder for wheat, oats, and other small grains which sprout and discolor easily when left on the ground.

The reaper is built on the order of the mower, but with only one, large drivewheel, from which the power is taken in about the same manner as in the mower. The sickle is run by a short pitman rod from the main shaft. In addition, there is an upright shaft with a heavy housing, equipped at the top with a wide collar which has a deep depression on the outside next to the platform.

Four large rakes or sweeps are pivoted at the top of the upright shaft, and as they revolve are each supported by a roller that runs on the collar. As each roller comes to the depression, the rake dips down and sweeps the platform clean, depositing the bunch behind the reaper, out of the way of the team for the next round.

The platform is usually about 5 feet wide and is supported on the outer edge by a small grain wheel. A circular rail is put on the back side of the platform, to conform to the swing of the rakes and to aid in guiding the bunches as they are delivered to the ground.

**The kafir header.** Kafir corn, milo, maize, and similar crops may either be cut with a corn binder and shocked or it may be headed, leaving the stalks in the field.

The kafir header is a simple machine, attachable to the side of a wagon box. It has a long, narrow platform, equipped with an endless-chain conveyor. On the outside of the platform is a high shield which tapers to a point, to act as a gatherer.

The machine is attached to the wagon at a decided angle, with the gathering point down. It is driven by a sprocket and chain from the rear wheel of the wagon. As the heads are fed back to the conveyor, they are caught by the revolving points of a star-shaped knife and cut off, then elevated into the wagon box.

**The bean harvester.** The early method of harvesting beans was to pull the mature plants and cure them in piles or on stakes. Of recent years, a bean harvester has been developed, and its use is widespread. Essentially, this implement consists of a frame on wheels and carries 2 knives. These blades slip along just beneath the surface of the ground, cutting and throwing together 2 rows of beans at the same time. Harvesting should be done when the plants are mature, but should not be delayed until the pods are too ripe as considerable loss may be caused by shattering.

## Corn Harvesters

**The corn binder.** Corn is a difficult crop to handle with machinery on account of its size and weight, and also on account of the loose soil in the cornfield, which makes it very difficult to secure sufficient traction to operate a machine. To overcome these difficulties and to make a successful binder, it was first necessary to make a heavy machine. The drivewheel is of good width and equipped with lugs to grip the soil. A short, heavily trussed main frame extends out from the drivewheel and is supported on the other side by a lighter grain wheel.

From the outer portion of the frame 4 steel beams or tubes are carried forward several feet. Two come together, forming a point on the outside, and the other 2 come together on the inside, forming another point. These are the gathering points of the machine. The 2 inside bars converge, almost coming together at the point at which they reach the main frame. At this point, a sloping or curved knife is riveted to each beam; and directly behind these stationary knives is a large single-sickle section that works back and forth, driven by a pitman rod.

At the outer end of each gathering point is attached a shield board, which extends backward and upward to the main frame of the binder. Under each shield board are located 2, and sometimes 3, sets of conveyor chains. These chains have extended lugs, which reach out into the narrow passageway between the 2 shield boards.

When the binder is being operated, the driver lowers the 2 gathering points sufficiently to catch any down stalks and drives down a row so that the corn stalks must enter the passageway between the shield boards. The conveyor chains hold the corn upright, and each stalk is sheared off by the stationary knives or the sickle. It is possible to lift and cut any stalk of corn that is not lying in exactly the same direction the binder is moving.

After the stalks are cut, they are shifted

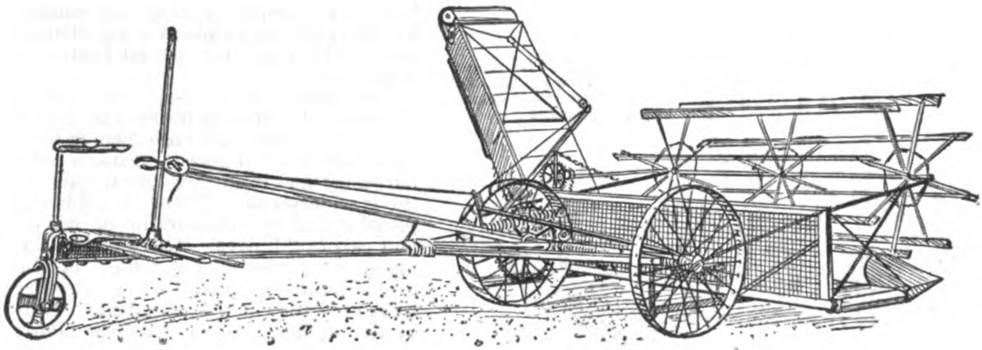


FIG. 154. The grain header used mainly on the sorghum crops does a similar work but is an entirely different implement from the grass seed stripper (Vol. II. Fig. 274)

back to binding position. Some binders lay the stalks down, and others stand them up in a butt pan for binding. The latter device seems the more practical for all kinds of corn, as this pan can be raised and lowered to suit the height of the corn.

**The binding mechanism.** The binding mechanism is the same in principle as that for small-grain binders, The stalks press against a spring trip rod as they are fed in by the packers. When this rod is tripped by the weight of the corn, a needle carrying the twine comes forward, passing the twine over the knotter, and the bundle is tied. When the trip is sprung, the discharge arms are also released and force the bundle out on to the bundle carrier or into the elevator.

The bundle carrier is at the rear of the machine and usually somewhat to the right, so that the bundles may be delivered far enough to one side to be out of the way of the team when cutting the next row. From 3 to 5 bundles may be carried; they are dropped by means of a small foot treadle under the foot of the operator.

The elevator attachment is an important addition to the corn binder, when filling the silo. The bundle carrier is taken off and the elevator attached to receive the corn directly from the discharge arms. Each bundle is then delivered directly to the wagon, as it is driven alongside of the binder. The elevator frame is adjustable, so that it may be raised or lowered to suit the height of the load.

Every corn binder should be equipped with a tongue truck. Without a truck, the heavy binder is very hard on the necks and shoulders of the horses. Where a truck is used, it is also much easier to turn at the end and make a square corner. Some trucks are now built so that the wheels turn at an even greater angle than the pole, thus making a square turn exceptionally easy.

**The corn picker.** The corn picker, or field husker, is a comparatively recent invention and is still in the process of development.

In design it looks somewhat like the corn binder, having the same long gathering points that run close to the ground. Just inside of these points, gathering chains with extended lugs are usually placed. These lugs assist in picking up down corn and feeding it back.

As the corn leaves the gathering chains, it is caught between 2 snapping rolls. These rolls may be made with ribs that start at the bottom and wind toward the top, corkscrew style, or they may be corrugated. The rolls snap the ears from the stalks, leaving the stalks and leaves in a pretty badly mangled condition. After the ears are snapped off, they are carried around to the husking rolls. These are generally 8 in number and work in pairs, the individual rollers in each pair running in opposite directions. In some machines, the rolls are set side by side; in others, one roll of a pair is slightly higher than the other.

Each set of rolls is equipped with a husking device, according to the manufacturer's idea. Some have raised shoulders and husking pins, while others have alternating sections and cylinders. As the corn is delivered from the snapping rolls, it is put in a lengthwise position by means of agitators. This gives the husking rolls a chance to tear

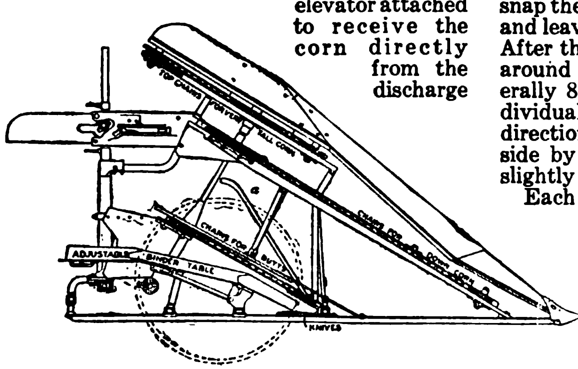


FIG. 155. Diagrammatic skeleton side view of a typical corn binder (Office of Experiment Stations, Bulletin 173.)

away the husks. Any corn that may be shelled off, together with the husks, falls through the rolls to a cleaner chain or conveyor. A screen is provided to catch the corn, which is carried back to the wagon elevator while the husks fall back on the ground. The wagon elevator is so adjusted that it may be raised or lowered to suit any wagon. Some machines are now made so that the elevator may be thrown out of gear independent of the husking part. This arrangement is very convenient for turning, as there is often not room for the wagon to turn with the picker. When the wagon is in position again, the elevator is once more thrown into gear and the accumulated ears pass on to the wagon.

Like the corn binder, a picker can get all of the down corn except that lying in exactly the same direction in which the picker is moving. The machine is very heavy, and usually requires 5 horses to pull it. Besides this, an extra wagon must be driven alongside to take care of the husked corn. Where labor is scarce, some men make a practice of taking 3 or 4 wagons to the field and husking them full before unloading any. In this way 2 men can husk and crib about 5 acres in a day, provided there is an elevator at the crib. The average corn picker is still far from perfect; but the machine is correct in principle and will undoubtedly soon be in common use on farms which are large enough to warrant the employment of such equipment.

## Potato Diggers

**The walking digger.** This implement looks much like a walking plow, except that it is fitted with a broad, bill-shaped shovel or scoop, instead of a moldboard. Attached to the back of the shovel are iron rods. The potatoes are lifted out of the ground by the scoop and pass back over the rods, which sift out the dirt leaving the potatoes uncovered in the furrow.

**The riding digger.** This digger has a long, sloping frame supported by the drivewheels. Each wheel is equipped with soil lugs, to insure plenty of traction. At the lower end of the frame there is a pointed scoop. The bottom of the frame is a slatted endless-chain conveyor.

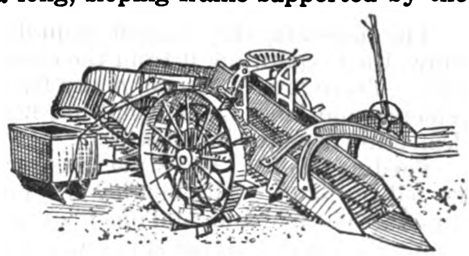


FIG. 156. An improved potato digger carrying a gatherer which does all the picking and delivers the crop a boxful at a time.

The potatoes are lifted out of the ground by the scoop; and, as they are carried back, the dirt falls through the slats, while the potatoes are delivered over iron bars at the rear to the ground again.

On one digger, a side elevator has been added that places the potatoes in a basket or hopper instead of letting them fall to the ground. The potatoes may be dumped in piles on the ground or put in baskets, crates, or sacks. This attachment does away with a great deal of hand labor, and should be extensively used in potato-growing sections.

The potato digger is a heavy draft machine and must be strongly built to resist the wear. Where the digging season extends over a number of days, a small binder engine may be mounted on the digger to run all parts except pulling the machine forward. This will greatly lessen the draft of the implement.

## Cotton Pickers

An efficient cotton-harvesting machine would be a boon to a huge army of American farmers. Unfortunately no such implement is yet found in the field as a practical, thoroughly reliable, satisfactory piece of farm equipment. Nevertheless the following report from Mr. Arthur Johnson of the Experimental Department of the International Harvester Company, is interesting both as a statement of conditions in 1917, and as a forecast of possible developments in the future:

"There have been efforts for the last 25 years to produce a cotton picker; the efforts have been divided mainly into 2 classes. The first and oldest type of picker is one in which there are a large number of spindles located on a revolving cylinder, 2 cylinders being used, one on each side of the plant. The spindles revolve on their own axes, and protrude into the plant as the machine is hauled along the row of cotton and as the cylinder revolves, there is mechanism on the opposite side to doff the cotton and elevate it into a sack.

"With this type of machine the cotton picked is dirty, and loses some of its value in grading on that account. Moreover, as you doubtless know, the cotton ripens gradually, the bolls on the lower part of the plant ripening first, and as the season progresses those bolls higher up in the plant gradually come to maturity.

"In using a machine of this kind there is a chance for some of the immature plants to be spoiled. Then again, in spite of the fact that some of the men engaged on the development of this type of machine have been able to apply an unusually large number of spindles and place them as close together as mechanically possible, they often miss some of the bolls of cotton and do not do a clean job. Our observation on this type of machine leads us to be very skeptical as to any possible success.

"The other type of machine is the pneumatic type, where a man has a number of nozzles operated in connection with a blower and the nozzle used to suck the cotton out of the boll as it is presented to each boll, and is used in lieu of the fingers of the hand picker, so to speak.

"This type of machine does a clean job, the cotton grades well. The machines are so far along that they operate without trouble. The grave question about this type of machine is whether it is any faster or more economical than hand picking, as to make it a practical machine. This scheme has possibilities in it, in our opinion, depending upon the skill of the designer in getting a nozzle with the flexible pipe connected back to the blower in such shape as to be handy to the operator."

## Grain Separators

The successful threshing of grain depends first on getting the grain out of the straw, then separating it from the chaff, and finally delivering it to the wagon or sack. There are, of course, many features about a thresher that make for convenience and labor saving that are not essential to the main task of producing clean grain from the bundles.

**Feeding device.** Old-style threshers and many of the smaller rigs used to-day are fed by hand. The bundles are pitched to a platform on either side. The bands are cut by hand, and one man feeds the grain into the cylinder.

A self-feeder equipment is now used in most places. This feeder is simply a platform hinged to the thresher at the cylinder, and equipped with an endless conveyor which carries the bundles to the cylinder. There is a guard board on either side, and a dividing board down the centre; this is to keep the bundles coming straight to the cylinder, where the machine is being fed from both sides.

The most important thing about the self-feeder is the governor. This is so timed with the cylinder that, when the cylinder speed is reduced to a certain point, the feeder stops automatically, thus keeping the machine from becoming choked up and wasting grain. It is very important that the governor device for the feeder should always be in first-class condition.

In the way of saving labor, the self-feeder does away with 2 band cutters and the feeder. It would soon save its cost on the saving of labor.

**Cylinder, concaves, and band knives.** As the grain leaves the feeder, it is caught by the band knives, and the bands are cut. These knives may be of the revolving type or may work back and forth on a bent crankshaft. The straw then passes between the cylinder and the concave teeth, where most of the grain is knocked out. The new types of cylinders are made of iron bars with rows of teeth bolted in place. There is an open place between the bars, so that no grain can lodge. The number of bars used is variable; but, for successful threshing, the fewer the number of bars, the greater must be the speed of the cylinder, and vice versa.

The concaves are in rows directly under the cylinder, the teeth being so set that there is a little clearance between them and the cylinder teeth. Adjustment for this distance can be made as required. The number of con-

cave bars used is also variable according to threshing conditions. The concave bars are usually divided in one or more places by a blind bar that is grated, so that the grain will fall through on to the grain pan.

**Grates and beater.** Directly back of the concaves and extending backward and upward is a grate. This grate is provided with large openings, so that most of the grain falls directly through to the grain pan

The beater is stationed just above the grates. It has much the same action as a flail, beating grain out of the straw that escapes the cylinder and concave teeth, and forcing the shelled grain through the straw so that it will drop between the grate bars on to the grain pan.

**Straw conveyors and racks.** After the straw has passed the beater, it is taken by a conveyor to the racks. Some conveyors are of the open-web type, operated by sprocket and chain. Others are of the push-bar type, made of notched wooden bars that move back and forth on a bent crankshaft. Both types allow grain to fall through to the grain pan, if it has been able to pass over the grate.

The straw passes directly from the conveyor to the racks. These racks are the width of the machine, and extend back to the straw carrier or blower. Racks of the newer type are designed to have a circular or rotary motion, that is, up, forward, down, and back. This keeps the straw from bunching, and passes it to the rear in a steady stream. Any grain that may still be caught in the straw is shaken out, and drops through the racks into a return pan, which works it forward to the grain pan or conveyor.

**Stackers and blowers.** After the straw reaches the rear end of the rack, it is passed on to the stacker or blower, as the case may be. The stacker is merely an outside elevator attached to the rear end of the machine. It is adjustable up and down, and most stackers may be extended in length as the stack goes up.

The wind stacker, or blower, is most commonly used. As the straw leaves the rack, it is forced through the blower pipe by a wind blast from a fan in the lower part of the rear end of the machine.

**Grain conveyor and sieves.** The grain pan or conveyor extends the length of the machine from front to rear. The rear end of this conveyor is known as the chaffer sieve. It is full of oblong holes, with the punched-out metal turned up to form rows of tips down the length of the sieve. A chaffer extension reaches back to the fan chamber, so that much of the chaff, short pieces of straw, and sticks are worked over to the blower.

A cleaning fan is placed under the machine somewhere near the centre. A wind board is so located that the blast from this fan strikes the conveyor about half-way back. The strongest part of the blast will then pass through the shoe sieve near the front end, giving it cleaning capacity its entire length.

The grain passes through the shoe sieve, falling on a solid surface, called "the shoe." This slopes down to the grain auger. As the grain slips down the shoe, it must pass over a screen at the back of the shoe, where most of the weed seeds not previously removed are taken out.

**Tailings auger.** Under the chaffer extension and back of the shoe sieve and shoe is the tailings auger. This catches unthreshed heads, grain that is blown over, and trash from the conveyor that has not passed out to the blower, and brings all of this material back to the cylinder again.

Few tailings should be returned. If much good grain comes back, it may come either from the conveyor or from the shoe sieve. If it comes over the shoe sieve, there is probably too much chaff on the sieve. To remedy this, close the chaffer sieve above slightly. If, however, the good grain is coming through the chaffer extension, then the chaffer should be opened still more.

When the clean grain gets to the grain auger, it is elevated to the weigher or wagon spouts or sacking spouts, as the case may be.

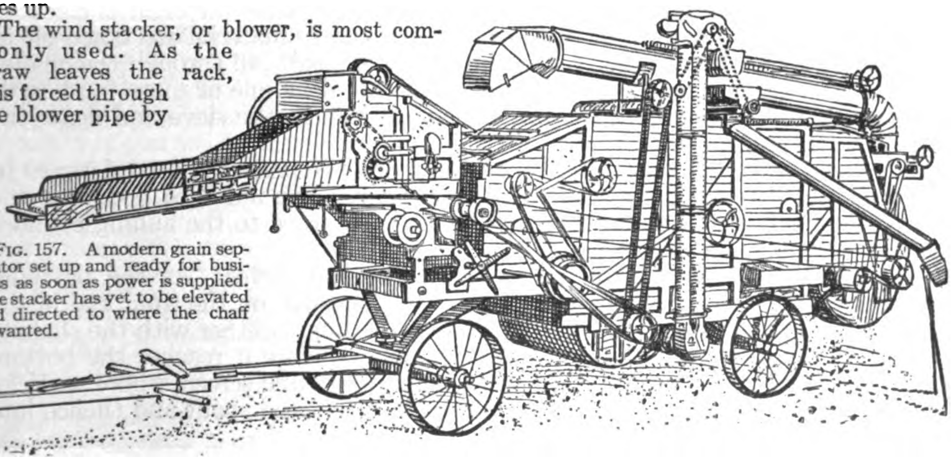


FIG. 157. A modern grain separator set up and ready for business as soon as power is supplied. The stacker has yet to be elevated and directed to where the chaff is wanted.

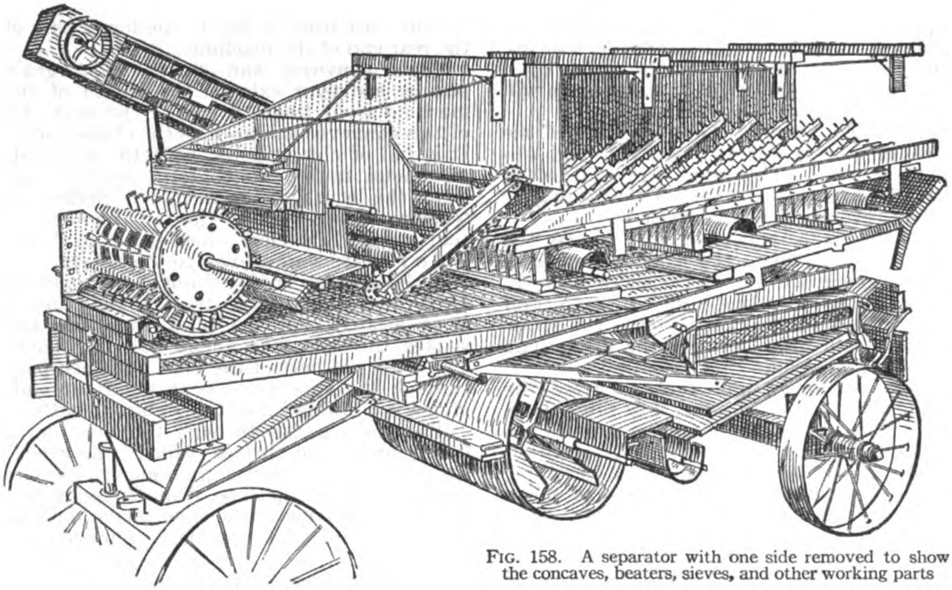


FIG. 158. A separator with one side removed to show the concaves, beaters, sieves, and other working parts

## The Clover Huller

The clover huller is much the same in principle as the grain separator, but essentially different devices are used to accomplish the work.

As the clover is fed into the machine, it passes between the cylinder and concave teeth, where the heads are knocked from the straw. All of this material passes back on a shaker floor or separating table. The floor of this table is slotted so that the chaff and heads will fall through; but the heavy straw is worked back to the blower, or stacker, by saw-toothed strips which run the length of the table.

The chaff and heads may pass through one or more shakers, according to the make of the huller, and are then delivered to the hulling cylinder.

This cylinder and the concaves may be equipped with rasps or steel beads. Both do effective work; but it is claimed that in damp clover the rasps are more apt to gum up.

After leaving the hulling cylinder, the hulled seed with the chaff is elevated to a chaffer sieve, where most of the stems and coarse material are taken off to the blower, as in the thresher. The seed and fine chaff fall through the chaffer on to a finer-meshed shoe sieve. Underneath this sieve one or more fan boards are placed. The blast from the fan comes up through the sieve and floats the chaff toward the blower.

The seed and chaff that fall through the shoe sieve pass over a sand screen to the seed auger and are elevated to the recleaner. The unhulled pods and the heavy chaff fall into the tailings auger, and are returned to the hulling cylinder to pass through the machine again.

The recleaner contains an independent fan and sieves. As the partially cleaned clover comes from the main shoe, it is deposited on the front end of the upper sieve of the recleaner. The blast from the fan, together with the shaking motion of the sieves, accomplishes the cleaning. Before it reaches the bottom of the sieve chamber, the seed must pass over another sand screen, where particles of sand and soil are removed. It then runs into the seed spout and thence into the bag.

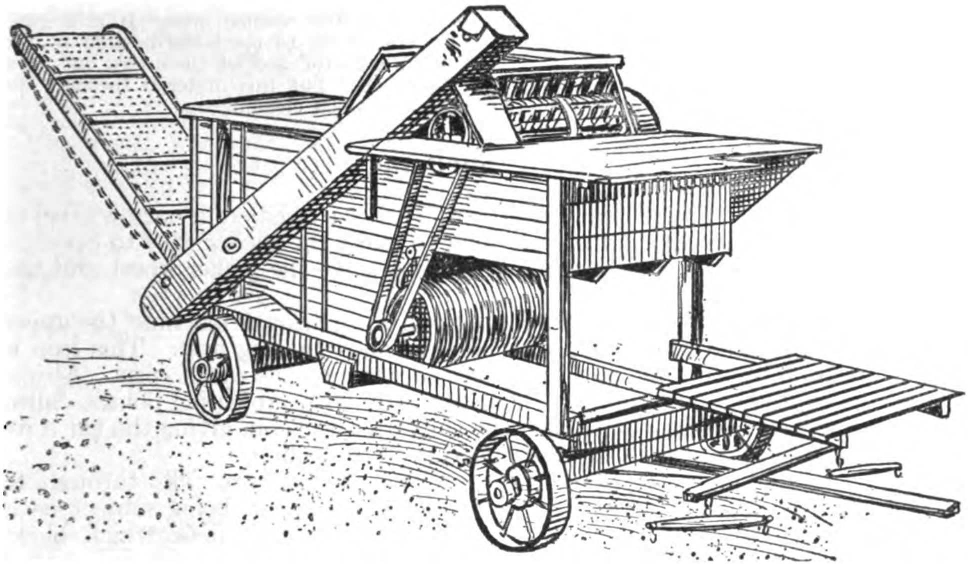


FIG. 159. The pea and bean thresher is rapidly extending its field of usefulness as cowpeas, soy beans, and other legumes are more widely grown throughout the South

**Hulling with a separator.** Clover may be hulled with a grain separator by inserting a set of special concaves filled with corrugated or rasp teeth. It will also be necessary to close up the shoe sieve if it is adjustable, and better work will be done if a regular clover sieve be placed under the shoe sieve.

To secure good, clean seed, a recleaner, like the regular recleaner on a clover huller, can be secured for most separators. This is attached to the side of the machine, and operates as described above.

The clover-hulling attachment will do very good work when hulling sweet clover, owing to the fact that the seed is so easily knocked off the stems. With other clovers, however, there is a considerable waste of seed, owing to the fact that there is no hulling cylinder in a separator and the rasp teeth fail to knock all of the seed out of the chaff.

**Pea and bean threshers.** The successful hulling of peas and beans presents a more difficult problem than one would naturally suppose. These crops absorb moisture readily after being harvested, and there are invariably a number of pods that are tough, even though the straw seems dry. In addition to this, there are always on the vines late pods that are hardly mature when the earlier pods are beginning to shatter. This variability in maturing also makes for difficult threshing.

Regular pea and bean hullers are built on the same general lines as a grain separator, but are equipped with two cylinders instead of one. A slow speed must be maintained to avoid cracking beans, particularly the ripe ones. For this reason the front cylinder is run slower than the back one. Most of the ripe beans are knocked out of the pods by the front cylinder, and fall through the grates and racks to the grain pans before reaching the second cylinder. The second cylinder runs at a higher rate of speed than the first, which tends to knock the beans out of tougher pods. All of the coarse material passes from the second cylinder to the straw racks. These are equipped with lifting rakes which keep the straw well agitated. Hulled beans and unthreshed pods fall through to the grain pan. Most of the unthreshed pods go over the chaffer to the tailings auger and are returned again to the second cylinder for hulling.

The cleaning of peas and beans is not essentially different from that of grain, as previously described. A special grader or delivery spout is used, however, to aid the work. This grader has a vibrating motion. A small screen at the bottom permits sand, dirt, and small stones to fall through to the ground. A coarse screen above separates sticks and pods that may have escaped the sieves. The peas or beans fall through this screen on to the bottom one and are delivered from one spout while the trash falls from another.

Peas and beans may be hulled with fair results by an ordinary thresher if it is properly equipped. The cylinder speed must be decreased; the chaffer and shoe sieve should be adjusted and opened a little wider than for wheat; and the extension beyond the

chaffer must be opened wide enough to permit unhulled pods to drop through to the tailings auger.

If hulled beans are returned with the tailings to the cylinder, there will be more cracked beans with the cleaned ones. It is a good plan, therefore, to open the bottom of the tailings elevator and let them run out on a canvas, then put this material through the separator when cleaning up.

## Corn Shellers

**Hand shellers.** The ordinary hand corn sheller consists of a narrow steel or wood-frame box, with legs sufficiently long to make the sheller easy to operate.

Two styles of shelling devices are in general use—the picker-wheel and the cylinder sheller.

In the picker-wheel type, an iron chute leads down into the machine, the upper part being adjustable with sharp iron points, called the rag iron. This iron is held in position by a spring, and brings the pressure on the ear of corn. At one side of the chute is a large upright revolving plate with projecting points, called the picker wheel. These points shell the corn from the cob, giving the ear a revolving motion in the process and thus insuring clean shelling.

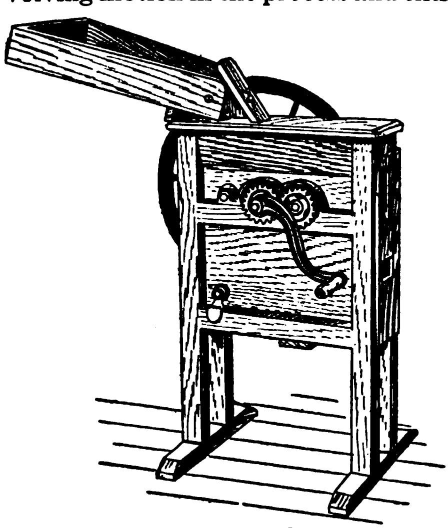


FIG. 160. The hand-power corn sheller has long been one of the most widely used of all American farm implements.

The shelled corn falls through to the delivery spout, being subject, as it descends, to a wind blast which blows out the chaff. The cobs are carried upward by the picker wheel and delivered to the outside.

The cylinder shellers have a conical iron grate for a chute, in which an iron cylinder studded with many projections is revolved. Since the size of the grate decreases toward the lower end, increasing pressure is put on the corn. The projections on the cylinder shell the corn from the cobs, giving each ear at the same time a revolving motion, just as in the picker machines. Similarly the shelled corn falls through the grate bars and is delivered below, while the cobs are pushed on through to a separate delivery spout.

**Power shellers.** Power shellers are designed for commercial work or for large farms where much shelled corn is used. In most communities where corn is sold in quantity, it is shelled on the farm before being hauled to the elevator. This practice is a distinct advantage in many ways. There is less bulk to haul; the grade of the corn can be readily established, thus insuring an equitable price to the producer; and the farmer can usually shell his corn cheaper per bushel than the elevator man is willing to do the same work.

**Shelling device.** Practically all power shellers are built with either a picker-wheel or cylinder shelling device. In principle, these two devices are the same as described under "Hand shellers"; but they are built larger and stronger to suit the requirements of heavier work. Owing to the fact that considerable trouble arises from breakage of the springs that put the pressure on the rag iron in the picker wheel, the cylinder shellers are growing in favor for commercial work.

**Self-feeder.** For both styles a self-feeder is now invariably used. In the picker-wheel type, there are several holes, each lead-

ing down to an independent wheel, the number of holes depending on the size of the sheller. The self-feeder must be designed to shake the ears down into grooves, so that each groove will deliver its ears lengthwise into a sheller hole.

**Separation.** When the ears of corn are forced through the shelling device, the grain falls downward, but the cobs and pieces of husk are caught by a conveyor and carried to the outside of the machine, usually being delivered to a V-shaped cob stacker equipped with an elevating chain. The conveyor has a set of agitators which keep the cobs and husks stirred up, so that any loose kernels that have caught in this material will fall back to the rear shoe and thence down to the grain auger.

**Recleaning.** The bulk of the grain falls straight down from the shelling device, striking a front shoe that is directly over the fan. As the corn comes over the edge of this shoe, it is subject to an air blast, which removes the chaff and stray bits of husk. The grain then falls into the grain auger and is elevated directly to the wagon or to sacks.

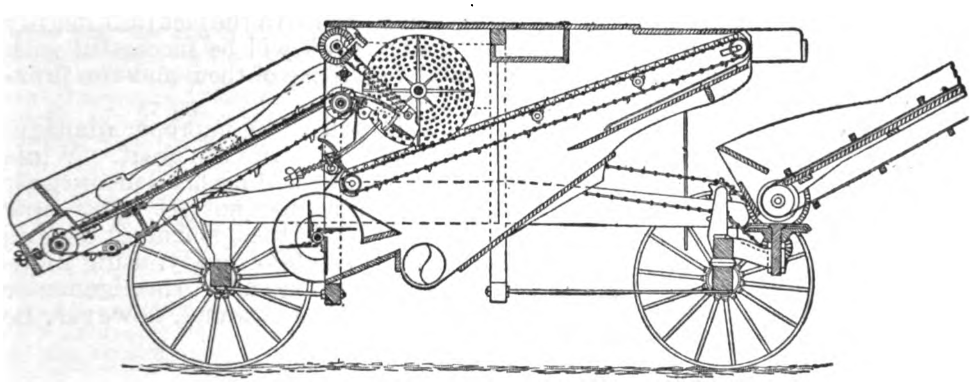


FIG. 161. The power driven corn sheller, a product of corn belt needs and tendencies

## CHAPTER 10

# Machines Used in Preparing Crops for Use

*By* F. H. DEMAREE (*see Chapter 7*). *The easiest possible way to dispose of a crop is to pasture it; where this is impossible machine harvesting must be resorted to. Some crop products go still farther and require an additional handling; for example, baled hay, ensilage, etc. The machines and implements used in thus working over or "changing" the important crops, and the right way to use them, form the subject of this chapter.*—EDITOR.

MANY of the machines described in this chapter are complicated and expensive. The observations of the writer point plainly to the fact that neither the individual farmer nor one engaged in custom work will be successful with many of these machines without careful study of each one of them and the functioning of its parts.

Not only may an expensive machine be quickly ruined by improper management and want of care, but the chances of serious accidents are great. While this chapter was being written, a friend of the writer's caught his hand in the gear of an ensilage cutter and had a finger torn off—and he does not yet know how it happened. Manufacturers are taking pains to make their machines as safe as possible: enclosing gears, extending oil pipes to points of safety, using high-class materials, etc. Consequently, most accidents are traceable to negligence or ignorance on the part of the operator. Intelligent care cannot, however, be exercised without knowledge of the machine.

## The Hay Press or Baler

Baled hay or straw occupies only about one fifth of the space required to store the same material when loose. This fact is in itself the chief reason for baling. If barn room is inadequate for loose hay, baling will generally be found cheaper than additional buildings. The bulk of hay and straw is so great that it must always be baled for shipment. Bales for the market should be tight, neat, and trim; the successful operation of the baler is, therefore, important.

**The hopper.** The main part of a baler consists of the hopper and the baling chamber, which latter is merely an extension of the hopper, made of heavy angle-iron bars. The hopper is solid on both sides, but opens directly into the baling chamber on the inner end and has a false end on the other, which is pushed forward to compress the hay or straw. This is known as the plunger.

The hopper sides are extended upward and outward above the level of the baling chamber, to secure greater capacity. An extension from one side forms the feed table.

**Feeder and plunger.** As the material to be baled is pitched into the hopper, it must be forced far enough down for the plunger to push against it. In old-style balers, the feeder does this with his foot. In modern balers, a self-feeder has been devised that works alternately with the plunger, forcing the charge of hay down between strokes.

The self-feeder consists of a heavy steel arm with a right-angle bend. It is hinged at the upper end and geared with the plunger, as indicated above. The other end of the arm is equipped with a broad feeder head with sufficient surface to force the hay to the bottom of the hopper.

As the hay reaches the bottom of the hopper, the plunger starts forward. Two styles of plungers are used: the pitman, which pushes the block, and the toggle-joint plunger, which pulls instead of pushing. When the pitman type is used, the power must be located back of the hopper. Where the toggle-joint plunger is employed, the power is in front of the baling chamber, the plunger rod running underneath the chamber floor.

The pitman plunger works on the same principle as any ordinary pitman rod. Where the toggle-joint plunger is used, at the beginning of the stroke, the rear toggle link is

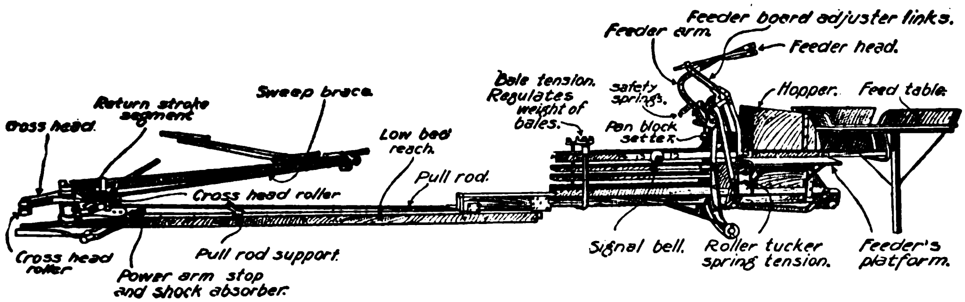



FIG. 162. The essential working parts of a horse-operated hay baler

pulled upward until the stroke is half completed and the link is in a vertical position. As the stroke advances, the pull at the joint begins to straighten out the links, and increased pressure is the result. There is some danger of buckling with a pitman-style plunger, but none with the toggle-joint type.

**Bale tension.** The outer end of the baling chamber is fitted with a tension rod which encircles both sides and bottom of the chamber near the rear end. Across the top is a tension tie, through the ends of which the tension rods pass. The tension-rod ends are threaded and fitted with a hand wheel or other tightening device. As these are screwed up, the tension on the end of the bale increases. Some tension rods are constructed to permit tightening from the side as well as from the top and bottom. This is known as the double-bale tension. Proper tension insures a neat, compact bale.

**Blocks and block setter.** The proper length of the bale is indicated by a signal bell or is ascertained by watching a measured scale on the bale chamber. When a bale in process of formation reaches this point, a heavy block, usually of wood, is inserted in the bale chamber, to cut off the finished bale and allow a new one to start. In some balers, the block is inserted by hand; but in the modern power types an automatic block setter is used. A special case for the block is located under the feeder arm. When the block is set, the case is tripped by a hand lever, and as the feeder arm goes on the downstroke, the block case is carried forward and downward to the bottom of the hopper. A bracket on the feeder head pushes the block into the bale chamber, and the case returns with the upstroke again.

The blocks are so constructed as to leave 2 large grooves on both faces. These grooves are about 6 or 8 inches apart. As the new bale is pushed forward, a wire is inserted through each groove next to the straw. As the next block appears, the same wires are inserted through the grooves of that block, so as to encircle the bale. The ends of each wire are spliced loosely and, as the bale leaves the chamber, the expansion of the straw draws them tight.

**Power.** Balers are operated by both horsepower and motor power. Owing to the size and capacity of the baler, a 1- or 2-horsepower sweep is furnished. Those operated by motor power are of various sizes and may be driven by stationary gas or kerosene engines, mounted on special trucks for the purpose, or by small tractors, steam engines, or unmounted engines which have sufficient power to carry the load.

Where horsepower is used, the sweep is attached to the outer end of a heavy beam extended from the baler proper. Underneath the sweep is a sprocket segment with an extended arm called the power arm. The plunger rod is attached near the outer end of this arm. A heavy crosshead is attached to the inside end of the sweep, with a roller at the other end and on the under side. As the sweep comes around, this roller engages the power arm, causing the plunger inside the hopper to move forward. The pressure increases until the roller reaches the other

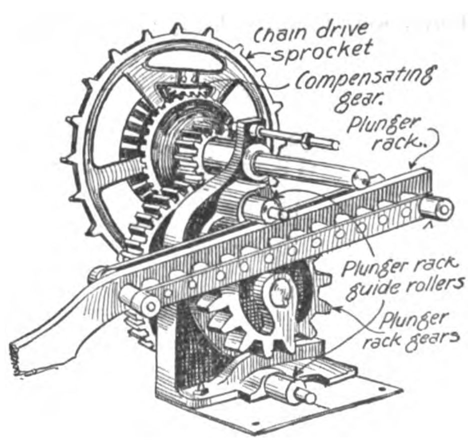



FIG. 163. Details of the apparatus by which the hay-baler is operated by engine power.

end of the arm; which causes the plunger rod to be released and spring back for the next stroke.

Where motor power is used, a power jack takes the place of the sweep. The end of the plunger rack is made to mesh with the driving gear of the jack and is held securely in place by heavy rollers. It is driven forward to the end of its stroke, then automatically released and allowed to return for the next stroke.

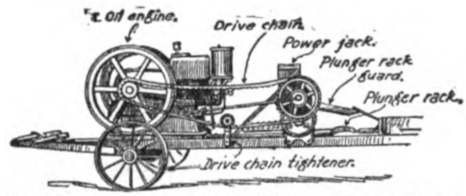


FIG. 164. The driving equipment of a power hay baler. The rest of the machine is the same as in Fig. 162

## Silage Cutters

The use of silage is becoming more widespread each year. As corn is the main crop used for silage purposes, the cutter must be designed with special reference to this crop.

In design, the silage cutter is a long, narrow conveyor attached to a circular fan case. In some machines the cutting knives are on the fly-wheel inside of the fan case; in others, the knives are bolted on a cylinder and are outside of the fan case. Machines of the first type are made with the fan case set at right angles to the conveyor. In the others, it usually sets parallel to the conveyor, the cut silage being fed directly into the fan from the cutting knives.

A long, adjustable pipe extends from the upper side of the fan case into the silo. The machine is mounted on trucks, front and rear, so that it can be transported like a wagon. Strong, heavy materials must be used if this machine is to stand up under its work.

**The conveyor.** The conveyor is of the endless-chain type, equipped with either steel or wooden slats. It is sufficiently long to accommodate a bundle of stalks lying flat, and it has guard rails on both sides. At the inner end of the conveyor a force-feed device is provided. This is usually of the fluted-roller style. The rollers are both above the conveyor and flush with its end. They are held under spring pressure, and revolve in the direction of the knives. As the cornstalks come between them, they are flattened out and held rigidly as they are being cut. The knives work against a heavy steel angle bar, known as the cutter bar, which is located just inside the feed rollers.

**Cutter knives.** As mentioned above, two different styles of knives are used in ensilage-cutter construction. Where the knives are bolted to the flywheel a simpler machine is produced.

In this type of cutter, a heavy, solid fly-wheel is placed inside the fan case. It revolves on the main driveshaft and just clears the

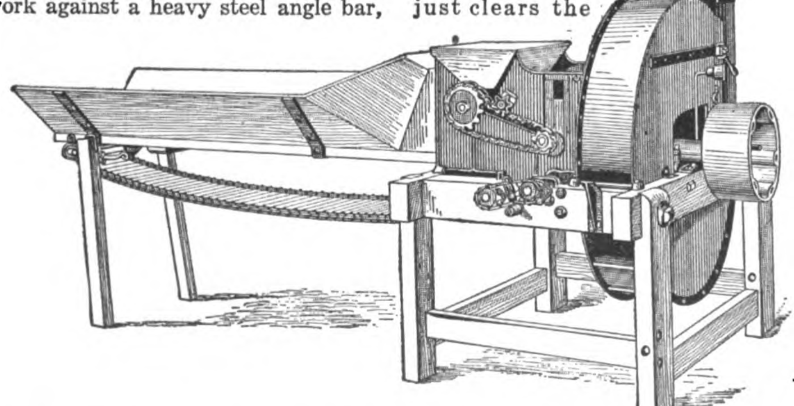


FIG. 165. Ensilage cutter complete, showing feeding platform at left, cutting knife compartment in centre, fan box and drive pulley at right, and base of blower stack in upper right hand corner

cutter bar. The shaft extends to the outside of the fan case, where the drive pulley is attached, and through the fan case to a small gear house, where power is transmitted to the conveyor and means provided to change the conveyor speed.

The flywheel has openings cut through, to conform to the opening from the conveyor. Above each opening a heavy knife is securely bolted. Below each opening there is a fan blade extending from the driveshaft to the outer edge of the flywheel and practically as wide as the fan case, allowing for clearance.

Where the knives are bolted to a revolving cylinder, they are generally somewhat curved and set spiral. This is an advantage over straight-set knives, as they slice instead of making a square cut. The knives on the cylinder work against a cutter bar, as described. The cut pieces of silage fall into a trough and are then delivered into the blower fan.

The bundles should be fed in butt end first, and, as the stalks are forced past the cutter bar, the ends are clipped off by the swiftly revolving knives. The small pieces are thrown and blown upward through the pipe to the silo.

**Care and adjustments.** Many accidents occur in operating silage cutters. Some of these are unavoidable, and others should never happen.

Do not lean against the conveyor. The clothing may catch and pull a person to the machine in that way. It is dangerous to attempt to remove an obstruction in or near the self-feed rollers while the machine is in operation. Throw it out of gear first.

It is also a wise precaution to tighten up the knife and fan-blade bolts at least once a day. If a knife blade gets loose, it is very apt to strike the cutter bar. In this case, something is bound to break. Flying pieces have often caused injury to the workmen as well as great damage to the machine.

The knives should also be kept sharp. Usually, two sets are furnished with each machine, so that one set can be sharpened while the other is in use. Dull knives do poor work and require more power. Some machines furnish a grinding attachment, run from the gear chamber, so that a set of knives may be ground while the machine is in operation.

Every silage cutter should be equipped with a clutch and a handy shifting lever. This lever should throw the machine in and out of gear, forward and reverse.

**Shock corn silage.** Corn that has had to be shocked and left to cure in the field may be cut with the silage cutter at any time during the winter. This is an especially good way to handle shock corn for winter feeding. The grain and roughage are thoroughly mixed, and the stock eat a greater portion of the stalks than would be the case if fed whole. In addition to this, the short pieces of stalk and pith that are not eaten make fair bedding, and are much easier to work up into manure than whole stalks. Unless it can be siloed (p. 465) do not pile up too much of this material early in the fall, as it is apt to ferment in warm weather.

## Corn Huskers and Shredders

The value of shredded corn stover is a moot subject. Some farmers rank it equal to timothy hay, others not so high. Feeding experiments have not shown that shredding adds enough to the value of whole corn stover to pay for itself, whereas the ensiling of stover if rightly done as mentioned above, is profitable.

It must be admitted, however, that shredding is gradually growing in favor, so that some factor other than cost must enter in the proposition. It seems to the writer that that factor is the production of easily-handled roughage.

It is a hard job to dig shock fodder out of the snow and hack the bundles loose from the frozen ground, and few farmers will undertake it on a large scale. Yet it is thoroughly recognized that fully 30 per cent of the food value of the corn crop in the stalks and leaves is lost if these are left to rot in the field. Shredding puts this food in an available shape, so that, although the cost may be increased over that of shock fodder, it is money well spent.

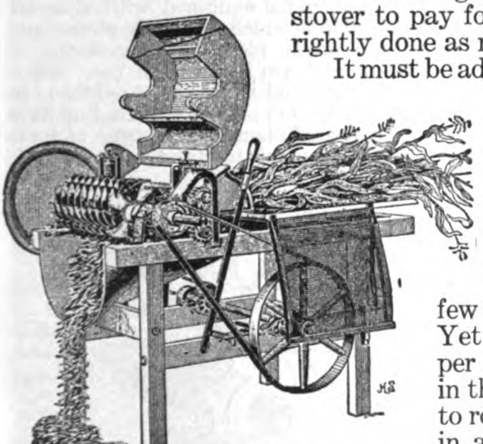


FIG. 166. Corn shredder with hood lifted to show course of fodder through knives (Office of Experiment Stations, Bulletin 173.)

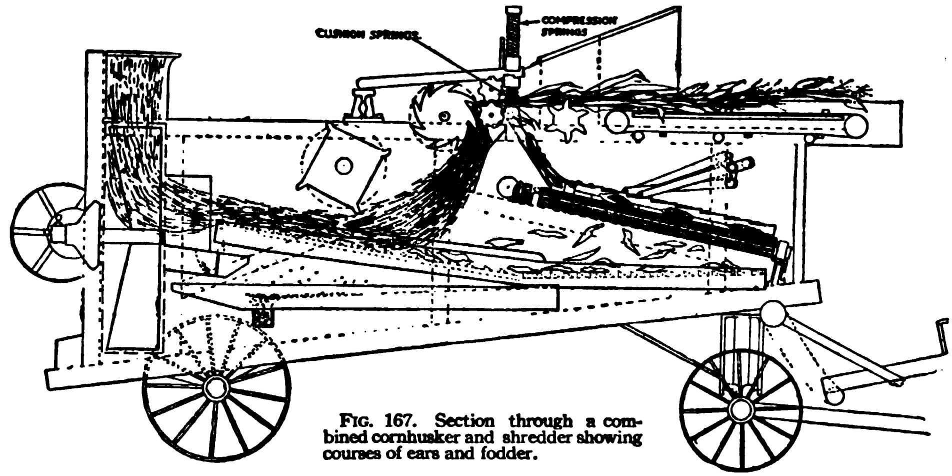



FIG. 167. Section through a combined cornhusker and shredder showing courses of ears and fodder.

**Design.** The husker and shredder is built along the lines of an ordinary thresher, but with special equipment for the work to be done. Many points of its construction are the same in principle as those of the separator, while many others correspond to those of the corn picker. Both of these machines are described in Chapter 9.

**Self-feeder.** The original shredder was made to be fed by hand; but so many accidents occurred that a self-feeder was designed, and this should be used on all machines. This feeder is simply an endless-belt conveyor, long enough for the bundles of fodder to be thrown on to it. At the inner end of the feeder is a separate revolving shaft equipped with spikes or knives. This is known as the feeder head, and assists in passing the stalks on to the snapping rolls. A sloping hood is placed above the feeder head, so that the ends of the stalks cannot fly upward and get crosswise of the feeder.

**Snapping rolls.** When the stalks leave the feeder head, they pass between 2 large snapping rolls, set crosswise of the machine. These rolls are very similar to those used in the corn picker, and answer the same purpose, namely, that of removing the ears from the stalks. In the shredder, the stalks pass completely through the rolls, while in the picker they do not. Snapping rolls of the better type are corrugated, so as to pinch off the ears with the least possible shelling. The rolls are held together under spring pressure. The stalks can pass through, but the pressure is so great that the ears are immediately broken from the shanks as they attempt to pass.

**Husking rolls.** The unhusked ears, after being snapped, fall directly down to the husking rolls. These rolls are in pairs, and in construction and operation are very similar to those used on a corn picker. The same variations in styles are found here as in the picker, and there seems to be practically no difference in their efficiency. The number of husking rolls found in a shredder increases with the size and capacity of the machine.

Agitators that work back and forth are placed over the husking rolls to keep the ears moving parallel with the rolls. This is essential to clean husking. As the ears move down the length of the husking rolls, the husks are stripped from the ears by the picker projections and passed downward to a shaker rack. The husked ears go on over the ends of the rolls into a conveyor, which carries them to the wagon box or crib.

**Shredder head.** When the stalks pass through the snapping rolls, only the ears are removed. The stalks are then immediately engaged by a shredder head or a set of revolving knives. The shredder head is a heavy iron cylinder equipped with close-set knives or plates which tear the stalks and leaves into small pieces. Many kinds of knife equipment are in common use. Some are saw-toothed and set in the shredder head on a spiral. Others are set square, but have a short right-angle bend. Any type of knife that is strong enough to stand up under this

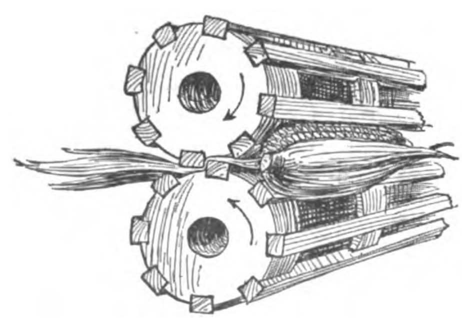


FIG. 168. Detailed view of husking rolls in a husker and shredder

heavy work and that does not powder the leaves too badly, is a good shredder.

**The shaker rack.** The shaker rack is placed just underneath the husking rolls and extends from the forward end of these rolls back to the entrance to the blower. The rack is perforated or slotted, so that any shelled corn or foreign material may be shaken through to the sieve below. The rack bars are saw-toothed, with their projections toward the blower.

The shredder head is directly above the shaker rack, so that the shredded stover is delivered directly down to the shaker. The husks from the ears are dropped on the forward end of the shaker by the husking rolls and shifted back to the blower with the shredded material by the back-and-forth movement of the rack.

**Saving the shelled corn.** The shoe is equipped with a sieve and screen the action of which takes out the dirt, snow, weed seeds, and other foreign material. The shelled corn is passed on to a conveyor, which delivers it to the sack. Usually, an air blast is taken from the blower fan to expel small pieces of stalks or leaves that may have remained with the shelled corn.

If shredded stover is to be kept any length of time, the removal of the shelled corn is important, as this will ferment during warm weather if left in the shredded material in any quantity.

## Feed Crushers and Grinders

There are 3 important objects to be attained in grinding feed, namely: to increase its palatability, to increase its digestibility, and to make available food material which in its natural state animals will not masticate. Much has been said and written about the value of ground feed as compared with feed in its natural state. Some experiments show that grinding pays well, others do not. This question of relative values, however, depends largely upon the first cost of the feeds under consideration. It is a safe assumption that, with the increasing cost of both grain and rough feed every process will be used extensively that will make available food materials that are now largely wasted.

**The sweep-power mill.** Probably the most common type of feed grinder found on the average farm is the one operated by a horse-drawn sweep. On account of the space required for the sweep, this grinder is usually set out in the barnyard. The mill is mounted on a base which catches the ground feed as it comes from the burrs. The mill legs, or supporting frame, are bolted to the base, which, in turn, must be anchored to the ground by stay rods and stakes. At the top of this supporting frame there is a large ring gear.

The upper part of the mill consists of a hopper, to which another ring gear is attached on the lower side. The upper gear is placed directly over the lower one, separated from it by small rollers that mesh in each. The sweep is attached to the upper gear and hopper, and when the mill is in operation these parts revolve on the lower gear, thus producing the power.

Heavy arms extend upward inside the hopper. They are attached at their outer ends to the main frame and to an iron collar in the centre of the hopper which they support. An iron spindle runs through this collar, supporting on the under side a set of revolving arms and a cone studded with heavy projections. When ear corn is being ground, the revolving arms crush the ears against the stationary ones, and the cone reduces the crushed portions to still smaller portions. The bottom of this cone has a corrugated section which acts as a grinding plate or burr. It works against a similar face on the inner side of the supporting frame, which is, of course, stationary. Since the grinding burr is cone-shaped, the opening between the 2 faces is wider at the top than at the bottom, so that increasing pressure is put on the material as it is forced through. Two sets of burrs are generally furnished: one with coarse corrugations for corn, and the other with finer corrugations for small grain.

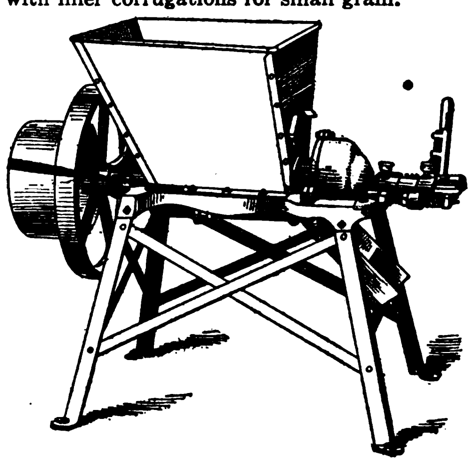


FIG. 169. Typical power-driven feed-grinder. Hand lever at right adjusts burrs and determines fineness of feed delivered.

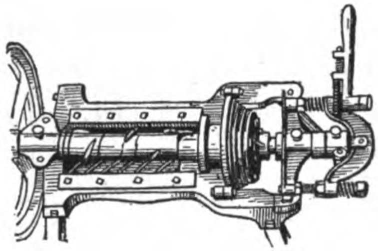


FIG. 169a. Top view of crusher and burrs, hopper and cover having been removed

The capacity of such a mill will range from 20 to 40 bushels per hour for ear corn and 10 to 20 bushels for shelled corn or small grain.

**Single and duplex grinding plates.** The ordinary belt-power grinder is made with circular opposed grinding plates or rings, either single or double, instead of the cones used in the sweep-power mills.

In single-plate mills one grinding ring is bolted to the housing which forms the grinding chamber. It has a specially corrugated face, which is turned to the face of the companion ring bolted to the driveshaft but adjustable there so as to give desired pressure.

In the double or duplex mills, the ring on the driveshaft has a grinding face on each side, and there are two stationary rings, one on either side of it. It can readily be seen that if the same grinding surface is to be secured with the single rings they must be of larger diameter. But with plates of larger diameter the grinding pressure is farther from the driveshaft; consequently, the power required to operate such a mill of equal capacity is necessarily larger.

**Feed-grinder construction.** The ordinary feed grinder consists of a hopper mounted on a sturdy frame with legs long

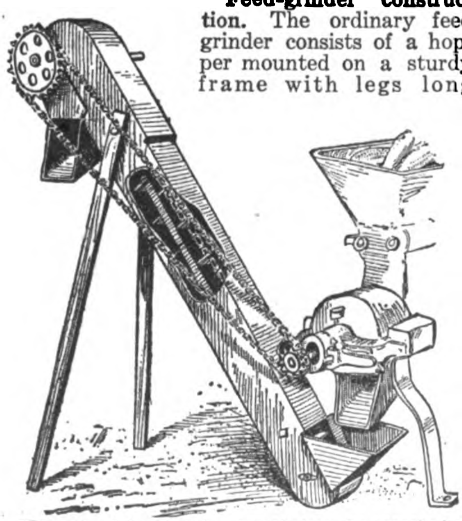


FIG. 170. A bagging elevator, that can be attached to any power-driven mill, saves much shoveling and prevents much waste

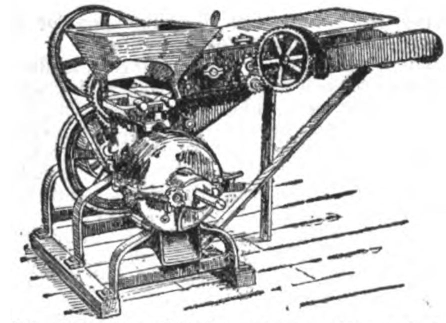


FIG. 171. A combined roughage cutter and feed grinder, by means of which a balanced ration can be prepared in one operation.

enough to give good clearance for the ground feed spout. The drive shaft passes through the bottom of the hopper and the exposed section is generally used as a crusher. This may be in the form of a spiral knife or of extended lugs set in spiral order, or it may consist of a combination of knife and lugs.

The crusher is used to reduce ear corn and other very coarse feed and also to act as an auger to force the reduced material into the grinding rings or burrs which may be set at varying distances apart so as to deliver feed of the required degree of fineness.

**Regulating fineness.** All grinders, whether of the single or duplex type, have a pressure regulating device whereby either fine or coarse feed may be produced by shifting the revolving burr on the shaft. All mills have a screw or lever device whereby this shift is made almost instantly and while the machine is in motion.

Most manufacturers make more than one set of plates for each mill. These are designed for either fine or coarse grinding, and will produce different grades of feed, according to the pressure put on them. The capacity of a mill is greatly increased by using coarse rings.

**Bagging elevator.** The bagging elevator is simply an enclosed narrow box with a dividing board in the centre. An endless-chain conveyor runs around the board, gathering the feed that is delivered to the bottom entrance of the elevator from the feed spout of the mill, and elevating it to the upper end, where the bag is attached. The elevator is supported by legs that can be adjusted to suit the height of the bags being used. A longer elevator may be secured to deliver the feed directly to a wagon box, if desired.

**Crushers.** It is often desired to feed corn merely crushed, not ground. Machines to meet this requirement are made by omitting the grinding plates and, usually, the lower crusher. The machine then consists of a hopper set on legs. One of the spiral crushing knives becomes the driveshaft as well; the other knife is geared to it; and the

operation is the same as previously described.

Since a grinder is generally desired on a farm where any of this work is done, most machines are constructed so that the grinding rings may be separated far enough for the crushed material to pass through without further reduction. In this way the grinder may be used as a crusher without the expense of buying another machine.

**Grinding mixed feed.** Two different kinds of feed may be ground and mixed together at the same time by attaching an extra hopper for the small grain to the edge of the main hopper. This secondary hopper is equipped with a slide in the bottom, by which the amount of grain fed in may be regulated at will. The upper and lower crushers thoroughly mix the two kinds of grain by the time they reach the grinding rings.

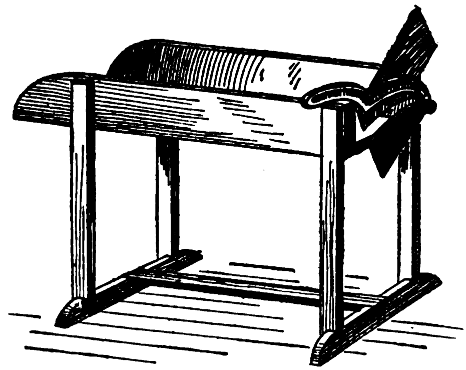


FIG. 172. The simplest type of hand-operated feed cutter

## Cutters and Grinders

**Roughage cutters.** The simplest form of rough-feed cutter is a knife hinged at one end to a cutting table and working against an iron cutting bar. The material is held in position by hand, and is cut in short lengths by bringing the knife down with the other hand. This is a very slow process.

An excellent cutting box, operated either by hand or by power, may be secured consisting simply of one or more pairs of knives set on a cylinder. As they revolve, they work against an iron cutting bar located at the inner end of a feed table from which the material is delivered to the cutting cylinder.

**Combined cutters and grinders.** A combined cutter and grinder can be secured that will cut and grind corn fodder, alfalfa, clover, pea hay, sheaf oats, or other rough feeds, together with ear corn or with ear corn and another small grain, if a secondary hopper is used.

This machine has an upward extension of the grinding chamber in which the cutter is located. A feed trough delivers into the cutting cylinder the material to be cut. For best results, the feed trough should be equipped with a force-feed device that will assist in holding the roughage for the cutter knives.

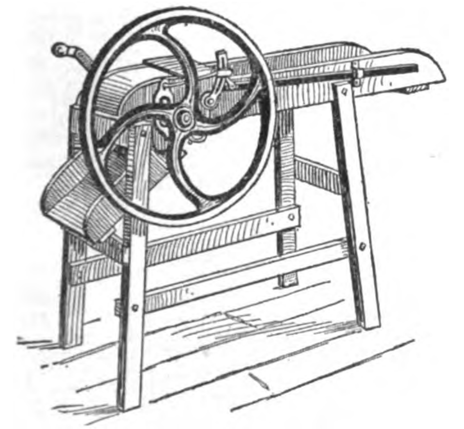


FIG. 173. A rotary cutter, even though hand-driven, is a great improvement over the type shown in Fig. 172

The small pieces of cut material are delivered to the lower crusher, together with the crushed grain from the upper crusher. All the material is mixed together by the lower crusher and forced into the grinding rings, where it is reduced to the desired fineness.

A combination cutter and grinder may be used either as cutter or as grinder, as desired. In producing cut feed alone, it is only necessary to open the grinding plates, so that they will not function. The feed will then be delivered in the condition in which it leaves the cutting knives. In case it is desired only to grind grain, the cutting device may be disconnected, and will remain idle during the process.

Such a combination machine means not only a saving in the first cost, but also a reduction of the amount of labor and space required for its operation thereafter. Another advantage is that, with such a machine at hand, the farmer will more readily utilize corn stalks and other roughage instead of wasting them. Fodder so prepared will be more nutritious, more palatable and more generously consumed by the animals. And they, in turn, as the result of the choice of the right machine will make increased growth and become more profitable thereby.

## Wood Saws

In timbered sections of the country, the farm woodlot generally furnishes its share of the farm income. Saw logs, cordwood, mine props, poles, etc., are all produced, according to the demand in the community. In the ordinary woodlot where the big timber has been removed, cordwood is usually the chief source of income.

Most of such wood may be worked up to advantage with the least labor by using a power saw run by a gasoline engine.

**Design.** The ordinary power saw consists of a heavy driveshaft mounted in a frame of convenient height. At one end, usually the left, if not otherwise specified, is bolted a circular saw. At the other end is the drive pulley and counterbalance or flywheel. Most saw blades are shielded with a hood or iron strip as a safety device.

**Tilting or sliding frame.** A section of the frame is designed to hold within itself the length of wood being sawed. In some cases this section is hinged from below, so that it can simply be lifted up and the wood pressed against the saw for cutting.

In other saws, the table slides back and forth between the saw blade and flywheel. Stop blocks are provided to hold the piece of wood steady. In sawing, the piece is laid on the table with one end extending beyond the saw the desired distance; the table is pushed forward, and the saw engages the wood in the process.

**The pole saw.** When it is desired to saw timber of considerable length, a saw should be secured which has the flywheel hung under the frame, out of the way of the table. This is accomplished by using a secondary shaft for the flywheel, below the main driveshaft. Extra pulleys and belting or gearing are required to deliver the power to the flywheel. The flywheel is stationed on the opposite side of the frame from the saw, to give the necessary counterbalance.

This saw may be used for cordwood as well as for sawing poles or other longer sections of wood. For the ordinary farm it is the best owing to its greater adaptability.

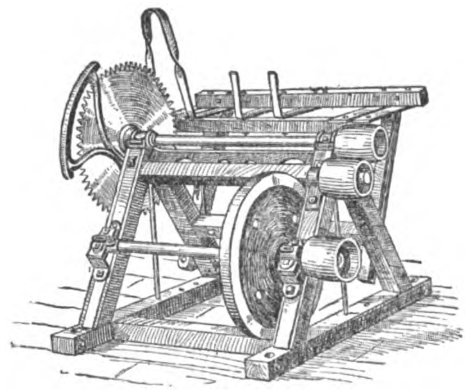


FIG. 175. Pole saw. The underslung fly wheel makes possible the cutting of poles of any desired length

**Portable saw rig.** For commercial use, a portable saw rig is a good investment. This rig has both engine and saw mounted on a heavy frame, the engine forward and the saw at the rear, with table dropped to a convenient height. In principle and operation, the saw is the same as an ordinary unmounted saw. The outfit is easier to transport and set for sawing, thus saving time.

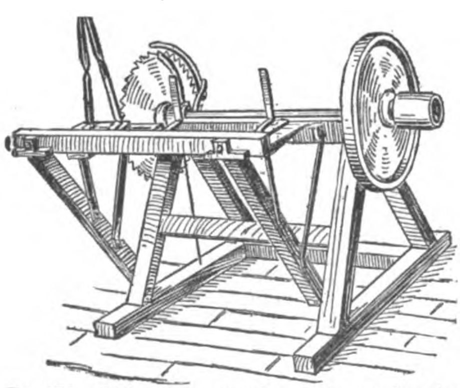


FIG. 174. Tilting frame wood saw, for cutting short lengths

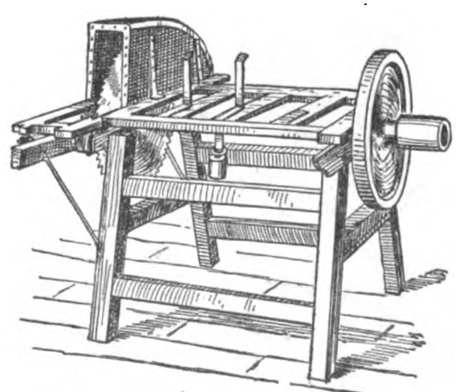


FIG. 176. Sliding frame saw with especially well-protected blade

CHAPTER 11

# Garden Implements and Hand Tools

*By* F. F. Rockwell, *practical farmer, gardener, author and contributor to agricultural and horticultural press. Though born in the city he spent many summers in the country even before he took up practical farming and greenhouse management in Connecticut in 1900. From 1906 to 1909 he attended Wesleyan University and was in the publishing business. In 1909 he returned to farming, practising also as consulting agriculturist. In 1917 in this latter capacity he was in charge Farms and its orchards. Later he became Manager of the Nurserymen's National Service Bureau.*—Editor.

THE importance of tools and machinery in the production of all kinds of garden and field crops is continually increasing. As the price of labor and the difficulty of obtaining skilled labor increase, the importance of an adequate equipment of those things which make labor more effective increases in proportion.

While the gardener and the farmer must depend more and more on the use of machinery, nevertheless there are two general conditions under which machinery will not and cannot pay, namely (1) insufficient use for it and (2) lack of attention to its proper care. These are so widely encountered and so serious that a word of warning in regard to them is in place. The mere fact that a machine will save labor is no guarantee that it will pay. *There must be sufficient use for it* to justify making the investment. A mechanical weeder for 10 rows of onions in the garden, or a potato digger for half an acre of potatoes would be an absurdity. Good judgment at this point is a most important factor in successful farming.

Still more important, however, is *the proper care of machinery*, once it is bought. It has been estimated by government experts that the farmer gets fewer hours of actual use out of many complicated machines than the manufacturer spends on them in their construction. Field-crop and garden machines of most kinds are adjustable or convertible for various operations, and are designed for very close and accurate work. Unless given excellent care, however, they will do poor work, will be much harder to use, and will soon become worthless. Every tool should be kept under cover when not in use, should be wiped and dried off immediately after use, and should always be kept well oiled.

## Tools for Working the Ground

Besides the standard plows of various types, there are a number designed particularly for garden work, either in addition to the others, or for turning the ground in very small areas where an ordinary plow is not available.

The 1-horse swivel plow (Fig. 177) is particularly useful for putting in succession plantings in small areas where a small block of some vegetable has been cleared off. It is good also for opening furrows or trenches, preparing ridges, etc. Another type of light 1-horse plow is furnished with a set of different moldboards for deep or shallow work, plowing growing vegetables, hilling up, and so forth.

A very convenient tool for small places or for garden work on the farm, to save the use of a plow and team, is the plowshare attachment for a regular 1-horse cultivator. This makes a substantial, small, reversible steel plow which will cut a furrow 4 inches deep and 8 to 10 inches wide.

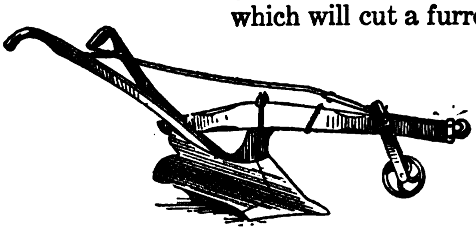


FIG. 177. One-horse, reversible or swivel plow, especially adapted to small garden use

The small garden outfit motor-driven and guided by a man walking behind, may also be utilized for light plowing. For the small place, devoted to poultry and "specialties," where a horse is not kept, this implement will do such plowing and cultivating as may be necessary, throughout the season, after the regular deep spring plowing has been done.

## Tools for Fining the Soil and Preparing the Seedbed

While the standard disc, spring-tooth, and spike-tooth harrows are used in the preparation of the soil in the garden and in intensive field operations or on truck crops, there are a number of special harrows made to meet certain conditions which are very widely used in making specially prepared seedbeds for potatoes, onions, tobacco, and the like.

**Harrows.** One of the most popular and generally useful of these harrows is the acme (Fig. 121), a pulverizing harrow and clod crusher. This is particularly valuable for use just before planting, as it turns up a fresh surface, the blades being so constructed that they form practically a miniature gang plow which thoroughly churns and turns up the upper 3 or 4 inches of the soil. It also does much more leveling than the ordinary harrow. Further, it can be set to be used as a smoothing drag. It is one of the most useful implements which the market gardener or truck farmer can possess. Care should be taken to renew the teeth often enough, so that it will continue to do as good work as when new.

The Morgan spading harrow, which is popular in some sections, is constructed somewhat upon the principle of the cutaway disc harrow; but the indentations are so deep that they leave a series of sharp teeth which cut deeply into the soil, chopping it up very fine, and also loosening it up. It is good on hard, compact soil such as may be deficient in humus, and where not much trash has been plowed under.

The Meeker smoothing, or small disc, harrow and leveler (Fig. 178) is used in the preparation of seedbeds that are required to be extremely fine, such as those for planting the seed of onion, lettuce, celery, carrots, and other fine crops. It practically takes the place of hand raking for finishing off the seedbed, one man with a horse and a harrow being able to do as much as 10 to 20 men could do by hand. The small revolving discs push under all small stones, trash, and other similar material—most of which a rake would pull out—and the adjustable leveling board smooths and levels the soil, leaving it almost like a table top. If possible, the last harrowing given with this harrow should be at right angles to the direction in which the rows will run, so that the lines made by the drill marker will be more distinct. This harrow is useful also wherever the creation of a fine dust mulch to retain moisture is wanted, and for covering in broadcast seed, grain for winter covered crops, and so forth. The chain, or link, drag harrow is also used for smoothing seedbeds and covering grains; but it does not do such thorough work as the Meeker; also it uncovers or collects trash and small pieces of manure which the Meeker harrow would push down out of the way.

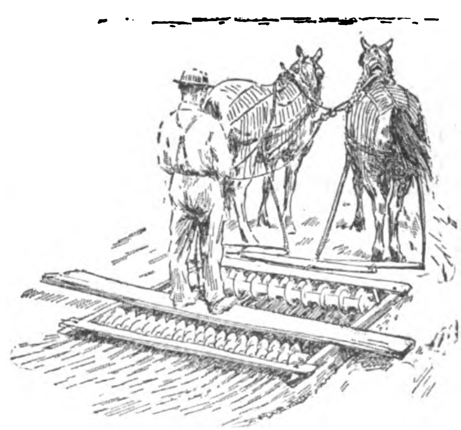


FIG 178. The Meeker smoothing harrow leaves the soil in the best possible shape for the sowing of vegetable seeds.

## Fertilizer Distributors

Intensive feeding of all garden and truck crops is one of the great factors in their successful cultivation. Sometimes, all the plant food to be used can be put into the ground before planting; but, in many cases, it proves more profitable to supply some of the plant food in the form of quick-acting fertilizer as top- or side-dressing in the drill or row with the seeds or plants, or as a top- or side-dressing during growth. The old method of doing this by hand was disagreeable and slow. A number of practical machines designed for this purpose are now on the market at reasonable prices. In the ordinary market garden or on the truck farm, a machine of this kind can be used frequently throughout the year, and, in addition to its use on vegetable crops, it may be employed to advantage on small acreages of potatoes or corn or root crops for truck for which alone its purchase might not pay. With a machine of this type it is possible to sow dry commercial fertilizers, of any kind and in any desired quantity, in open furrows prepared for planting or along the sides of rows, several rows at a time. The fertilizer is carried out of the hoppers steadily and evenly on endless canvas belts, and the spouts, which are adjustable, may be set to distribute it in narrow or in broad rows or broadcast. One of the larger machines will side-dress 5 rows any distance apart up to 2 feet, 4 rows up to 32 inches, 3 rows up to 4 feet, or 2 rows up to 8 feet, and will broadcast over a strip 8½ feet wide, the capacity being 400 pounds of fertilizer at a time.

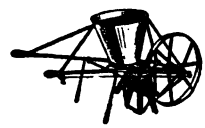


Fig. 179. Wheelbarrow type of fertilizer distributor.

For smaller operations, where only a limited acreage of truck crops is grown in connection with the general farming, a man-power distributor (Fig. 179) is a practical and rapid-working machine which will, with care, save a great deal of time and disagreeable work. It will, moreover, give better and more uniform results than hand distributing. It is particularly useful in growing strawberries and truck crops like cabbage and tomatoes. It can, of course, be employed in many places where a horse machine cannot be used. It will apply from 3 to 40 pounds of fertilizer to 100 yards of row, distributing between, or on both sides of, 1 to 4 rows at each passage; and it is not hard for the operator to use.

Some of the leading makes of wheel hoes also have fertilizer-distributing attachments which may be used with the seed drill or separately for top-dressing or side-dressing.

## Marking and Spotting Machines

Marking or "striking out" rows or check rows for planting seeds or setting out plants is one of those small jobs which cut down the total of a day's work; nevertheless, marking out must be done carefully and accurately, or it will interfere with the cultivation, whether by horse or by wheel hoes, throughout the season. Even with crops which are not usually planted in check rows, such as lettuce, early cabbage, and so forth, because of the extra time required to crossmark the rows when planting, some time may be saved in hoeing and wheel hoeing, if all the plants are accurately spaced.

The most complete and up-to-date tool of this kind (Fig. 181 *c*) admits of the following combinations: 5 rows 8 to 12 inches apart; 4 rows 14 to 16 inches apart; 3 rows 12 to 24 inches apart;

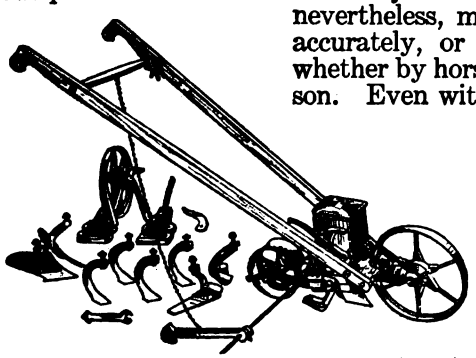


Fig. 180. A wheel hoe with complete set of attachments, including seed drill (shown ready for use), an extra wheel, and various types of cultivator teeth.

and 2 rows 25 to 48 inches apart. Not only are any of these combinations of rows marked off with accuracy at one passage, and a line marked for the return trip, but by the use of removable plugs on the circumference of the broad wheels, each row may be "spotted" for plants to be set 3, 6, 12, 15, 24, or 48 inches apart. For small gardens, a simpler machine is made, which will mark and spot 2 rows at a time; or one wheel may be used as an extra attachment to an ordinary wheel hoe. (Fig. 181 *a* and *b*).

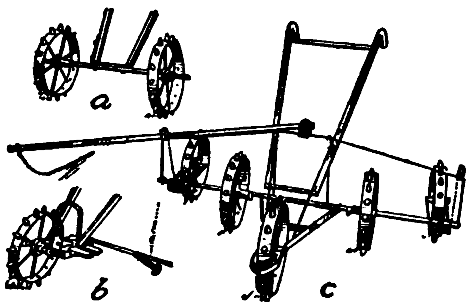


FIG. 181. A row marker adjustable for laying out from one to five rows, and for "spotting" at any desired distance in each.

There are adjustable markers which mark out the rows only; with these, however, as with the common homemade drag markers, it is much more difficult to make a straight row, as they are pulled behind the operator. Where there is not enough marking to justify the purchase of a regular marking tool—a device which does not cost very much and which with care will last for a generation—it will, however, pay to take the time, say, on some stormy day, to make a set of markers covering all the row widths which are likely to be needed. If these markers are made with a *detachable* handle, which will serve for all the "heads," they can be stored away in a small space and will be much less likely to get broken than when constructed in the ordinary way.

Various types of markers are used for field crops; but the best of these have discs instead of runners, and can be used as coverers and furrowers as well as markers. The ordinary "wing" marker is too widely known and employed to need description here.

## Planters and Transplanters

Accuracy in the sowing of seed is of the greatest importance. The yield with any crop depends directly upon the fullness and evenness of the stand obtained. It costs just as much to prepare the ground for, fertilize, cultivate, spray, and supervise the growing of, a poor stand as a full one. Careful work on planting may mean all the difference between profit and loss on the entire season's work. It pays to have the best of planting machinery. But planting machines are, as a rule, more complicated and more finely adjusted than those for other purposes, and they should be given particular care. *Never allow unused fertilizer or seed to remain in the machine*, and keep all planters not only under cover, but in a dry place and off the ground.

**Seed drills.** There are, in general, 3 types of seed drills, each of which has its advocates. The first of these, and the kind most commonly in use, has a gravity feed with a brush or a metal agitator working just above the seed opening in the hopper, to prevent packing or bridging of the seed. In the second, or force-feed type, the seed is carried out of the feed hopper by a revolving drum, in which there are small cavities into which a certain amount of the seed falls, being then dropped into the delivery tube as the drum revolves. Planters of this class do very accurate work; but, as they require separate cylinders or sizes of drums for different sizes of seed, and take longer to change, they are better adapted to large gardens or to work where a considerable amount of each kind of seed is to be put in than where changes will have to be made frequently. The third type operates on the "snap" principle, a spring-and-cam or trip mechanism being used in addition to the gravity feed. The modern drills are readily adjustable for the different sizes of seed, widths of rows, and so forth, and will sow in hills as well as in continuous drills. Except where there is a great deal of planting to be done, it pays to get a seed drill in combination with a wheel hoe. Market gardeners and others who have use for a seed drill frequently throughout the season prefer a separate drill.

For large-scale operations, the multiple seed drills, which will sow several rows at a time, are coming into more general use. Their advantage lies in the fact that not only is much time saved in the work, but each unit

of rows is spaced with absolute accuracy, even if the rows themselves are not perfectly straight. Machines for cultivating 2 or more rows at a time can, therefore, be used with much better results than where the rows are planted individually.

For very small gardens, and for use in greenhouses and frames, there are a number of small seed sowers (Fig. 182) designed with a handle for use like a slide hoe, or with a short handle for use on raised benches. Some of these open the furrow and cover the seed, others merely drop the seed; but they all save a good deal of time compared with hand sowing, and sow more accurately than an inexperienced operator can sow by hand.

FIG. 182. The smallest type of seed drill consisting of wheel, hopper, and furrow opener.

For very small plantings, of either potatoes or corn, hand planting machines (Fig. 183) can be used; and they will do the work much more accurately and very much more quickly and easily than it can be done in the old-fashioned way with a hoe. Machines of this type cost very little, are simple in operation, and, with ordinary care, will last indefinitely. Even where one has but a small patch to plant, the cost of one of these handy implements will be saved quickly. They are also particularly useful in going over the fields as soon as the plants are up, to fill in skips, which latter will occur, even in careful planting. For this purpose, they are invaluable supplements to the larger machines, and offer a means of stopping serious crop leaks which are often overlooked.

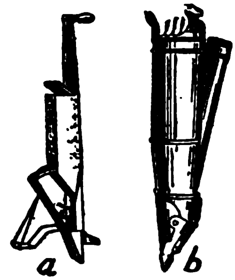



FIG. 183. Hand corn planter (*a*) and plant setter or transplanter (*b*)

**Plant-setting machines.** One of the slowest and most tedious jobs connected with gardening and trucking has always been the transplanting or setting out of plants from the seed-bed or coldframe. For a long time this work was done entirely by hand. At length, the plant-setting machine (Fig. 183) came to the rescue of the large planter. More recently a practical "back and time saver," in the form of a small hand plant-setter, has been invented, to serve the smaller planter and for jobs where the big machine would not pay.

## Weeders and Weeding Machines

One of the most important additions made within recent years to the general line of farm tools is that of the spring-tooth weeders, which are widely used for corn, potatoes, and many other rowed crops. Like most other agricultural tools, to do their best work, *they must be used at the proper time.* Intelligently handled, they are capable of saving, or rather of preventing, a tremendous amount of hand work. The old style of field weeder with 3 rows of spring-steel, pointed teeth was fixed to a light, rigid frame. The newer forms are adjustable in width and have removable teeth, so that, where desired, a tooth or two immediately over the row may be removed. A riding form, with adjustable spring tension on the teeth and with an extra feeding attachment for grass or grain has proved very popular in some sections. In operation, these weeders pass over the growing crops—corn, potatoes, and so forth—which are strong enough to withstand the light harrowing or raking given by the flexible teeth, while all small weeds, up to an inch or two in height, are pulled from the ground and shaken loose from the soil by the vibration of the weeding fingers. Besides removing the weeds that are close to the plants better than can be done with any form of cultivator, they loosen up and aërate the soil, and create a fine

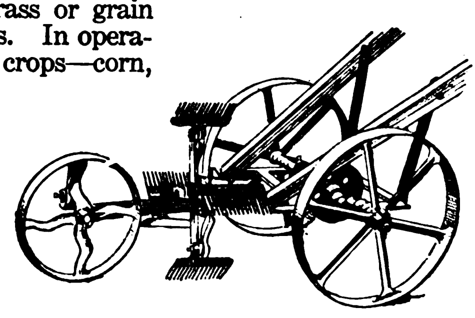


FIG. 184. One of the recent garden weeders in which the teeth revolve at right angles to the direction in which it moves.

dust mulch which is of great service in retaining moisture. They are especially good for getting over the surface of large areas in a short time after a rain, during the early stages of growth, preventing the crusting and baking of the soil.

Weeding machines, that is, machines for the actual removal of the weeds in a manner similar to hand weeding, as distinct from the tools, are a very recent development. While they are still being improved and have not yet come into general use, nevertheless they are being used extensively by a number of large growers and have apparently come to stay. They are peculiarly suited to work in light loam and in muck soils comparatively free from stones. They have proved of value for thinning rowed crops, such as carrots, as well as for weeding.

There are 2 general types of these weeding machines, one of which operates with wire fingers or weeders, and the other with a weeding blade or comb. In either case, the fingers or combs are passed through the row with a rotary motion by the mechanism of the machine. With the first type, the weeds are scratched or raked out; with the latter, they are caught, held in the comb, and pulled out. The comb machines will work, of course, only when there is enough difference between the form or size of the vegetables to be weeded and the weeds to be removed to allow the former to slip through the combs while the latter are held and pulled out.

## Cultivators and Special Tools for Cultivating

The riding and walking cultivators used for garden and truck crops are for the most part identical with those which are in use for ordinary farm crops. For garden and truck crops, however, it is especially important to have a machine that may be readily adjusted for width of row and depth of cut, and that will do fine and close work. A cultivator with *lever* adjustment for both width and depth should, therefore, be selected. In one of the latest types of the 1-horse cultivator, or horse hoe, the levers are out of the way and are easy to adjust while the machine is in operation, the frame is light but exceptionably strong, and the wide, flat back sweep leaves a smooth surface instead of a deep furrow as with the old-style, wide-back tooth. An important extra attachment for machines of this kind is the vine turner or leaf guard, which

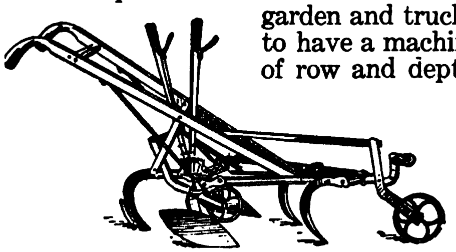


Fig. 185. For gardens more than 50 by 100 feet in size, a one-horse, adjustable cultivator is almost a necessity.

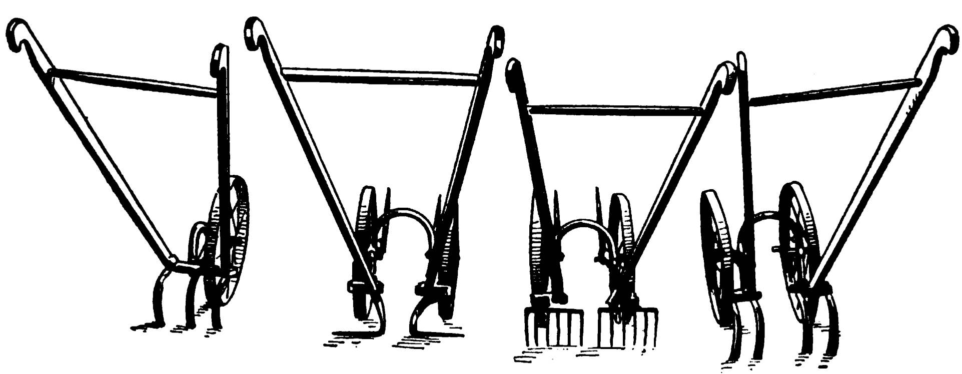


Fig. 186. Four wheel hoes showing single- and double-wheel types and three styles of cultivator blades

can readily be put on and which makes even closer work possible without injury to the foliage. The solid front wheel has this advantage over the old spoke style: it does not sink so deeply into the soil when the latter is very wet or very dry, nor does it get stuck by small stones or trash. One of the most popular tools with the market gardener, strawberry grower, and so forth is the 12-tooth, or diamond-tooth, cultivator. One of these machines, with the pulverizer attachment, which can be had to fit on the back end of the frame, will take out practically all small weeds, will work almost as close to the plants as one could with a hoe, and will leave the ground as finely pulverized and smooth as if an iron rake had been employed.

**Hand cultivators.** Hand cultivators, or wheel hoes, are so universally known and used that little need be said here concerning them, except that with a machine of this kind, used constantly throughout the growing season, and for many different kinds of work, it pays to get a tool of the best quality that can be had, even though it may cost several dollars more than an inferior one. Of course, such tools should be well cared for, and kept so free from dirt and rust that all changes and adjustments may be made easily and quickly. Very often this is not the case. While the single-wheel type costs less than the double-wheel, it usually pays best to get the latter, as it can be used to straddle the row, doing much closer work, especially while the plants are small, than the single-wheel. Also, for work in crops that are nearly grown, the double-wheel may be converted into a single-wheel in a few minutes. Among the most important of the many extras or attachments for standard wheel hoes are the "onion" or extra-high-guard hoe blades, the advantage of which is that, in close work, they prevent lumps of soil, small weeds, and so forth from falling over on to the seedling plants. This allows both the wheel hoeing and the hand weeding to follow it to be done more rapidly. Other particularly good attachments are the wide or flare-bottomed cultivator teeth, instead of the old standard narrow cultivator teeth. The advantage of these is that, while they break up the crust and pulverize the soil, they cut off small weeds instead of allowing the latter to pass around them as the narrow teeth often do. Plowing, raking, hilling, ditching, and furrowing attachments all have their special uses and, under many circumstances, will prove profitable investments.

## Machines for Special Purposes

In connection with some of the garden and truck crops, special machines have been developed for use in harvesting, preparing for market, and so forth. The most generally used, perhaps, of these is the potato digger. While there are a number of types of this machine on the market, it is doubtful if any are really satisfactory except the high-grade standard elevator diggers which are now universally used wherever potatoes are grown on a commercial scale. The recent addition of a small gas engine, to operate the mechanism of the digger, enables work which formerly required 4 horses to be done easily by 2. Moreover, it is done better, because the elevator, separating apparatus, and so forth is run at an even rate of speed, no matter how fast or how slow the machine may be moving ahead. The latest development is the picking attachment, which saves the labor of picking up from the row after the digging.

A new machine, which many large vegetable growers have found to be one of the biggest time savers ever introduced, is the "bundle-tying" machine for such crops as green onions, carrots, beets, rhubarb, asparagus, and so forth. This machine may be operated either by foot, somewhat like a sewing machine, or by power. Its tension may be varied to give moderate or tight tying; and it is adjustable for tying bunches and so forth.

## Hand Tools

The small, or hand, tools which are used with garden and truck crops are so numerous and so well known that they do not require any extended mention here.

Nevertheless, there are a few general considerations in connection with them which are too often overlooked. Such common tools as spades, digging forks, rakes, trowels, and hoes, while standard in general design or shape, vary widely in the quality of the material and in the kind of workmanship that goes into them. With these simple things, as with larger implements, it always pays to get the best, and then to take the best care of them.

FIG. 187. The machine buncher and tier is an invaluable labor and time saver for the market gardener who considers appearance worth while.

The difference between the work that can be done with a suitable, sharp hoe or weeder, and a poor-shaped or dull one, is considerable, even on a few rows of work; and, in the aggregate for the season, this may easily amount to the entire cost of a new implement. One marked feature, always to be sought in tools of this kind, is the *solid one-piece shank*, instead of the old-fashioned ferrule, which may wear or work loose. The selection of these tools always depends largely on personal preferences, as well as on local conditions. But there is often danger of preference becoming prejudice. The progressive grower should always be ready to give up something good for something better, in the little things as well as in the large.

**The spade and spading fork.** The spade and the spading fork, used for turning over small plots of ground, finishing up corners, and around irrigation posts, in the cold-frames, greenhouse beds, etc., are, perhaps, the simplest tools made. But even here quality counts. A poor spade or fork, soon bent out of shape and becoming loose in the handle, is a constant source of annoyance and of inefficient work. Buy the best, because it pays the best, and see that the handle is strapped with metal up the front and back, protecting it against breakage at the weakest point. The tool should, if possible, be selected personally, so that one with a suitable "hang" for the user may be obtained.

**Rakes.** The iron rake is one of the most constantly used tools in any kind of garden work. The size, number of teeth, etc., required will depend on the kind of work to be done. In preparing seedbeds, raking out weeds, and the like, a large-sized rake might often be used with a considerable saving in work where a smaller one is employed simply because it "will do." The "bow" rake, attached to the handle from the *ends* of the head instead of at the middle, is not so likely to break or bend at the middle as the ordinary kind; it is also better for leveling soil, in which the back of the head is used. A straight, strong, well-balanced handle is also an important item in securing good work with a rake.

**Hoes.** Most farmers are stingy with hoes. It is not at all unusual to find half a dozen old, round-cornered, loose-shanked, broken-edged hoes—some of them out in the fence corners—on a place where the gang plow and the riding cultivator and the cream separator are in prime condition and the mowing machine and manure spreader are under cover. The old-style, deep, heavy hoes were made before the days of modern cultivating machines. For most work with hoes nowadays, in garden and truck crops, the wider, lighter hoes will be found easier to use and more efficient. The very small, narrow-bladed, or "onion," hoe, is little known in many sections

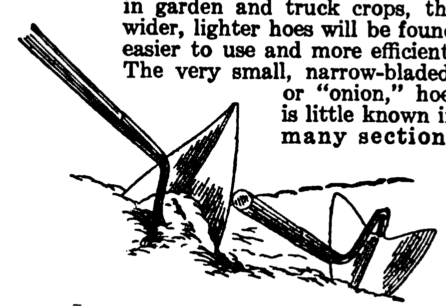


FIG. 188. One of the modern improvements over the old time hoe

where it could be used to great advantage. Of course, these lighter hoes are not adapted to "chopping" a thick sod of half-grown weeds; but, for stirring the soil around and close to plants, when the weeds are small, much easier and quicker work can be done than with a large, heavy hoe. An important thing to remember is, to *buy hoes with solid shanks*—ferrule and head in one piece.

For use in closely-planted crops, after they are well grown, the scuffle, or slide, hoe often has to be used to get through when the wheel hoe can no longer be used. A new type of slide hoe, which is proving very popular, has round iron runners in front of the blade, which is thereby held at a uniform angle, and does not glance to the side and thus injure the crop. Also, the weight of the tool is supported, so that it is less tiresome to use. A number of different blades, adapted to different kinds of work, give it a wide range of usefulness.

The smaller hand tools—trowels, transplanters, weeders, etc.—are, on the basis of the work they save in proportion to their cost, among the most important on the place. For this reason it will pay to see that they, also, are of the best quality when bought, and that they are taken care of afterwards. These small tools are so easily misplaced that a special spot should be assigned to them, and their return to that spot *immediately after use* insisted upon. A new type of trowel is found in the long, heavy-bladed one with the handle at right angles to the blade. This is especially useful in the transplanting of tomatoes, cabbage, etc.

When even a few of such rowed crops as onions, carrots, beets, etc., are grown, enough small hand weeders to equip as many hands as are likely to be working in them at one time should be provided. There are probably no other tools which will more quickly repay their cost in time saved, when conditions make their use necessary.

There are a number of new tools, such as adjustable weeding rakes, long-handled weeders, etc., on the market, many of which are excellent for general work or for special purposes. Before investing in any of these, however, be sure that they are substantially built to stand actual service. Many a dollar idea gets on to the market first in a thirty-five-cent dress.

*All edged tools should be kept sharp.* There is just as much waste of energy in using a dull hoe as in using a dull mowing-machine knife. They should also *be kept free from rust,* which greatly decreases both their length of life and their efficiency. A piece of an old burlap bag and a bottle of kerosene (kept tightly corked to prevent evaporation), to be used on the tools after they have been in use, will prove one of the most profitable small investments that can be made about the place.

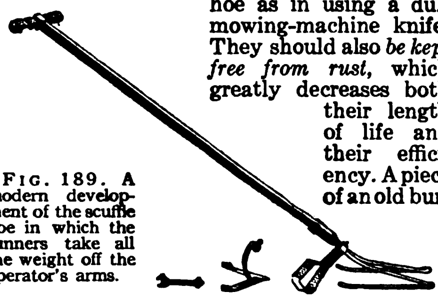
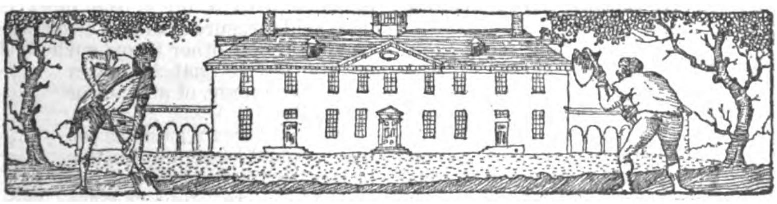


FIG. 189. A modern development of the scuffle hoe in which the runners take all the weight off the operator's arms.

Above all, the grower who realizes how much of his success must depend on the machines and tools he has to work with will provide room to house them from the weather. He will have a place for each, and will see that each tool after the season of its use, is put back in its place, and that any broken or worn-out parts are replaced *before the season of its use.* Though such advice may seem old-fashioned and trite, it is as true to-day as when first given.



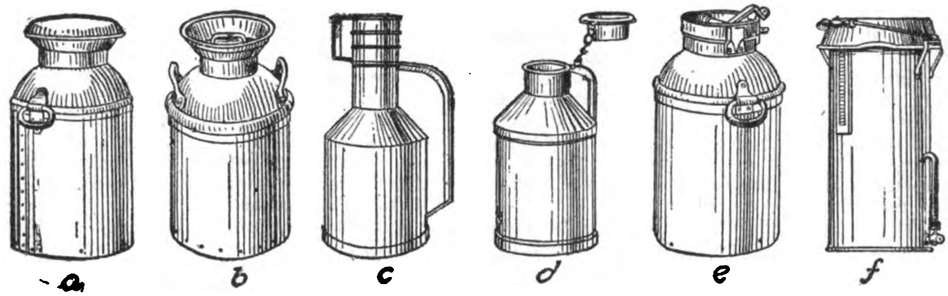



FIG. 190. Types of milk cans for various tastes and purposes. See text (pp. 139 and 140) for descriptions

## CHAPTER 12

# Dairy Machinery for the Farmer

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CHAPTERS 40, 41, 42, 43, and 44 of Volume I include some discussion of dairy machinery as related to the different lines of dairy work. This chapter treats many of the same tools and machines but more from their mechanical point of view. In this case it is the machine itself rather than the work it does and the reason for its use that is considered first. There are, of course, many makes and styles of these articles. Only the farmer himself can say which is best for his purposes; but this discussion will help him to decide carefully, wisely, and well.

**BABCOCK TESTERS AND EQUIPMENT.** The butter-fat testers now on the market vary from a little 2-bottle machine up to those handling 40 bottles and include types operated by hand, steam, and electric power. The smallest hand machine (Vol. I, Fig. 505) is useful when only a few samples are to be tested. It is light, well made and can be easily attached to any table or bench.

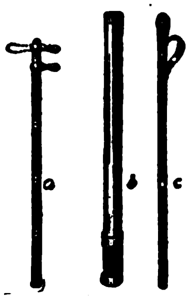



FIG. 191. Milk samplers. (See text)

For testing more samples the 8-bottle type is very satisfactory, turns easily and runs smoothly and quietly, but for a larger amount of testing a power machine is better than a hand one. An attached hot-water tank for filling the bottles is a great convenience.

Accurate glass-ware is one of the most important features of a testing outfit. The best is that made in accordance with specifications formulated and adopted by the Federal Bureau of Standards at Washington and the American Dairy Science Association and known as "Standard" Babcock test bottles and pipettes. The milk bottle is graduated to one tenth per cent, and the cream bottles to five tenths per cent. The straight sided cylinder with a lip is the most commonly used acid measure (Vol. I. Fig. 500 *e*), but some persons prefer other forms such as the dipper or, the device that measures the right amount of acid automatically.

Milk and cream samples for testing must be kept in bottles or jars with tight seals—either snap tops, screw tops or glass stopples—so that no moisture can evaporate.

**Milk samplers.** The McKay sampler (Fig. 191*a*) consists of 2 nickel-plated, brass tubes one of which fits inside the other, and both of which have milled slots that coincide

FIG 192. Combined acid bottle and pipette.

when the handles stand together. The slot so formed is closed by turning the handles at right angles to each other. The Scoville sampler (Fig. 191*b*) has a check valve which is closed by pressing the sampler down against the bottom of the can or vat. The milk thief (Fig. 191*c*) is simply a hollow tube in which the column of milk is held by pressing the thumb over the top. Each of these types of sampler is designed to take a column of milk the entire depth of the can or vat.

Cream to be tested by the Babcock method

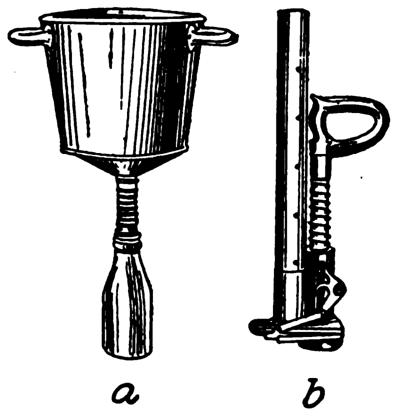



FIG. 193. Single-bottle hand filler (*a*) and hand capper (*b*). The proper caps are stocked in the cylinder

must be weighed on a sensitive balance. One of the simplest, least expensive, but wholly satisfactory forms on the market is shown in Fig. 212. It is fitted with agate bearings and is sensitive to one thirtieth of a gram. The empty cream bottle is balanced by a sliding poise with a balance nut; after the cream is added it is balanced by means of the hanging poise placed on the notched beam, the balance being clearly indicated by the pointer beam and indicator plate.

**BOTTLE FILLERS AND CAPPERS.** During recent years great improvements have been made in milk bottling and capping

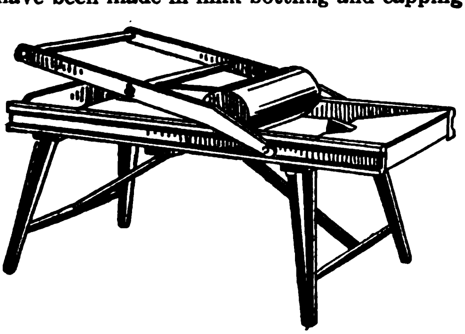


FIG. 194. Simple farm butter worker. (See text)

machines so that the dairyman may now select, from an almost endless variety, the outfit best suited to his special needs. For dairymen who fill not more than 100 or 200 bottles

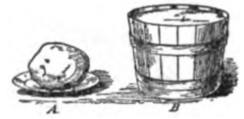



FIG. 195. Butter lost in separating when machine is level (A) and out of balance (B)

per day the single-bottle hand machine (Fig. 193*a*) will prove very satisfactory, easy to use and efficient. It is automatic, filling every bottle to the same point without overflowing. As the filler is placed on the bottle, the valve opens allowing the milk to flow and as it is removed the valve closes completely so that there is no loss by dripping. When considerable quantities of milk are to be bottled, a machine which will fill several bottles at once (Vol. I, Fig. 537) will be better than the hand filler.

The hand capper (Fig. 193*b*) provides a very satisfactory method for capping a limited number of bottles. When the capper is placed on the bottle, a thrust of the handle forces the cap firmly into position; as the handle returns to its position the next cap (from the stack in the cylinder) comes automatically into place. A capper of this sort can be worked rapidly and is more sanitary than handling the caps by hand.

**BUTTER WORKERS.** For use in connection with any small churn. There are several types of butter worker. That shown in Vol. I, Fig. 544 is an old standby in which the butter is placed in the tray, sprinkled

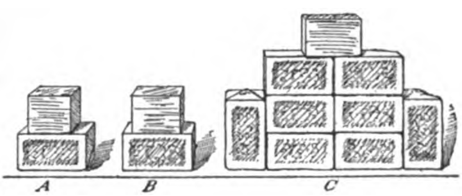



FIG. 196. Butter lost in separating one cow's milk for a year when the inflow of milk to machine is correctly A and B and incorrectly C adjusted.

with salt, and worked by turning the crank which moves the wooden roller over the butter. This process is repeated until the desired amount of working has been secured.

Another of the oldest styles is shown in Vol. I, Fig. 546. The butter is placed in this worker and subjected to the desired pressure by means of the lever which is pivoted loosely at the lower end.

In a third type (Fig. 194) the butter is rolled out into a thin sheet by means of the large wooden roller, sprinkled with salt then folded over with a hand ladle and rolled again. The proper amount of pressure can be obtained by bearing down on the lever, the lower end of which slides in grooves at the sides of the worker table.

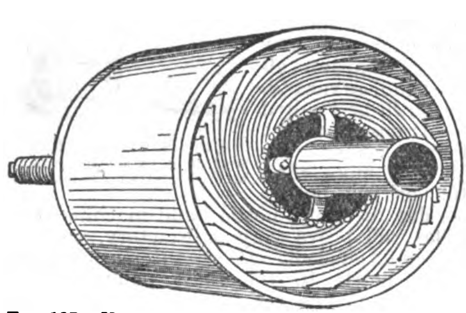


FIG. 197. View into the top of a separator bowl of the link blade type

**CENTRIFUGAL CREAM SEPARATORS.** The old-time methods of raising cream in shallow pans or by setting cans in cold water have given way very largely to the use of the centrifugal separator. The chief advantages of the latter, which are responsible for the change, are: (1) more complete recovery of the butter fat; (2) the richness of the cream may be controlled to suit the use that is to be made of it; (3) the cream is obtained fresh and is therefore of much better quality than when obtained by the slower methods; (4) the fresh skim-milk is at once ready for feeding calves and pigs; and (5) the time and labor saved.

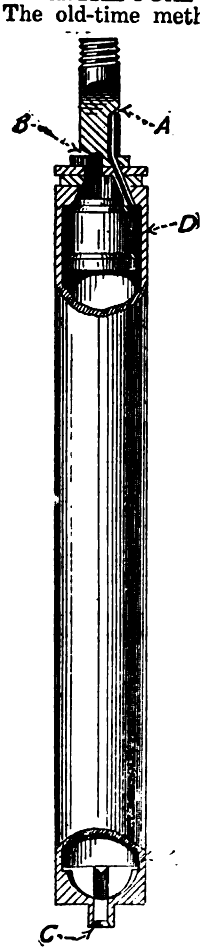



FIG. 198. Hollow bowl used in one type of separator. *a* skim-milk vent; *b* cream vent; *c* milk inlet; *d* dividing wall.

The modern cream separator was invented about 1879 on the principle that the fat globules in milk are lighter than the skim-milk, and that therefore, as the milk is revolved rapidly in the separator bowl, the skim-milk tends to flow toward the outside, and the fat toward the centre, of the column each running out through holes provided for it. The many different makes and styles of separators developed and placed on the market of late years, are all based on the same principles as the earlier ones, but differ widely in their mechanical details. The devices that separate the cream and skim-milk as they pass through the bowl may in general be divided into 3 distinct groups: (1) The disc type; (2) the link-blade type; (3) the hollow-bowl type.

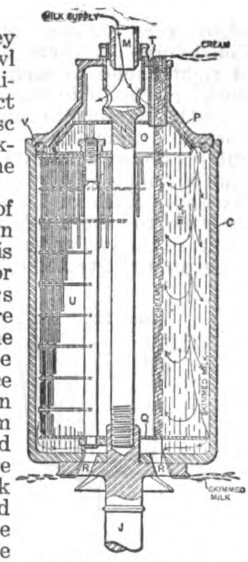



FIG. 199. Section through link-blade bowl as shown in Fig. 197.

A representative of the disc type is shown in Fig. 200. In this particular separator the milk enters through the centre and flows between the leaves or discs of the distributing device where the separation takes place, the cream moving inward and upward at the centre while the skim-milk moves outward and upward at the outside of the discs next the inner surface of the bowl. Both cream and skim-milk pass out through holes at the top to the delivery spouts.

In link blade machines (Fig. 197) the separation takes place as the milk travels between the curved blades of the separating device, the cream passing up and out at the centre and the skim-milk up along outer ends of the blades next the inner wall of the bowl.

In the tubular or hollow bowl type (Fig. 198) the milk enters at the bottom. The bowl revolves at a high rate of speed and as the milk moves upward the skim-milk moves out

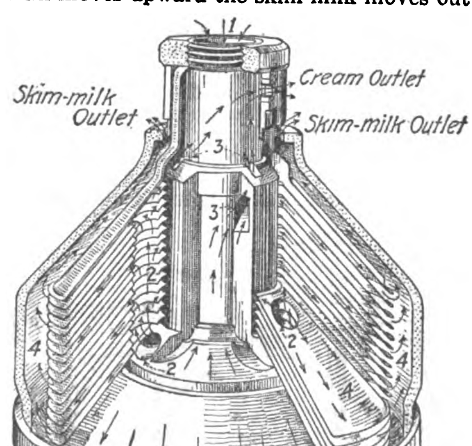



FIG. 200. Section and interior view of a separator bowl of the disc type

toward the wall while the cream forms a column in the centre. The chief features of this type are the long, slender bowl and the absence of an inner separating device.

**CHEESEMAKING EQUIPMENT.** For the dairyman who wishes to make small amounts of the soft cheeses such as cottage,

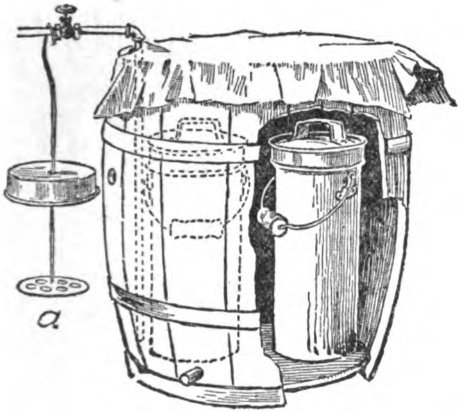



FIG. 201. Pasteurizing outfit that any farmer can make. A stirring device to be used in the can to insure even heating.

Neufchâtel, or cream, the following equipment will be found convenient and desirable.

Experience has shown that cheeses of better quality can be made if the whole or skim-milk is pasteurized. A simple, convenient outfit for pasteurizing small quantities consists of a barrel sawed off at the proper height with a steam pipe extending into it so that the water can be brought to the proper temperature (Fig. 201). Milk can be pasteurized in this barrel, in either the shot-gun or the 40-quart can; care must be taken to see that the milk is stirred so as to be uniformly heated. After the heating process has been completed, the same outfit can be used for cooling the milk by replacing the hot water with cold.

A convenient draining and curd table (Fig. 223) has racks in the bottom that allow the whey to run off through the outlets at one end. Pressure can be obtained as shown by wrapping the curd in the draining cloths, laying a board over the surface and setting upon it cans full of water. The sides of this table are removable for convenience in operation.

Convenient molds for making soft cheeses are shown in Fig. 202.

**CHURNS.** On many farms it is occasionally desired to make a small amount of cream into butter. For this purpose the little glass churn (Fig. 203) is very satisfactory. It consists simply of a heavy glass jar with a smooth steel screw-top and a well-made dasher operated by gears and crank handle much as in an egg-beater. Such churns are made to hold from 2 to 5 pints.

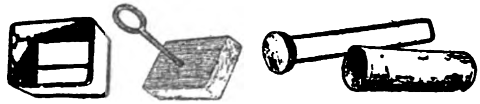


FIG. 202. Two types of soft cheese mold

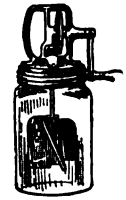


FIG. 203. Glass churn for kitchen use.

Three of the older types of hand churn are shown in Vol. I, Fig. 543. This swing churn is extremely simple with no floats or paddles inside, the rounded ends and slanting top producing the desired agitating of the cream. The fact that the opening is always on top is a favorite with many persons.

The barrel churn, usually made of hard wood, well bound with metal hoops, is one of the old standbys. The lid contains a sight glass so that the progress of the churning may be observed without removing the cover. The smaller sizes of this type of churn work easily by hand and give good results, but for the larger sizes it is well to have some kind of power.

The rectangular or box type is also well known on farms. It works easily, bringing a complete separation without injury to the

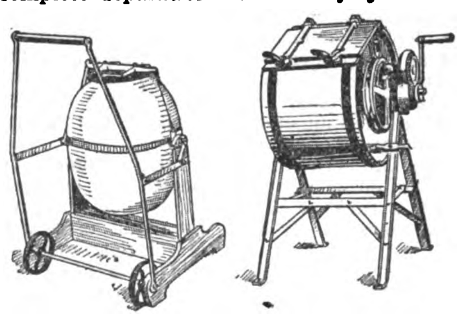


FIG. 204. Two sanitary modern churns. Stoneware type at left, steel barrel type with geared handle at right.

grain of the butter. The opening is large making the churn easy to clean and there is no mechanism inside.

One of the newer types of churn is made of fine glazed stoneware (Fig. 204) which will not absorb liquids, with a cover of clear glass through which the process of churning may be observed and which rests upon a rubber ring giving a tight joint. Its chief advantage is the ease with which it can be thoroughly sterilized and kept in perfectly sanitary condition.

Another attempt to develop a strictly sanitary churn has produced the steel barrel heavily tinned inside. The cover is cork lined making a perfectly tight joint.

In the power-driven combined churn and butter worker the processes of washing, working, and salting are done in the one container. The churn is provided with 2 rolls between which the butter is worked, and special gears which are thrown into place after the churning is completed and the working process is commenced. While exhibiting the good features of the modern creamery churn and butter worker, it is reasonable in price and is giving good satisfaction on many farms.

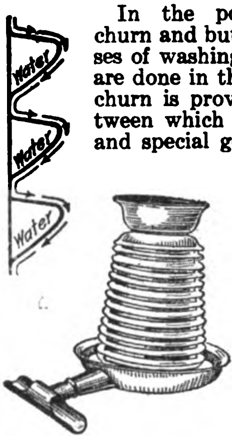



FIG. 205. Combined milk cooler and aërator. *a* section of spiral coil containing cold water.

**COOLING TANKS AND COOLERS.** In the handling of milk and cream no one thing is of greater importance than proper cooling, for which every dairyman should provide suitable equipment. The cooling may be done by setting the cans in cold or ice water or by running the milk over one of the many forms of coolers now on the market.

For a small amount of milk or cream, good results may be obtained by using a pickle or alcohol barrel, either full height or sawed off at the proper point to prevent the water getting into the cans, and either cold running water or broken ice. It is always well to use a thermometer for testing the actual temperature of the milk.

For larger amounts of milk, a homemade tank of either wood or concrete may be used. Such a tank as shown in Fig. 207 will give good service. It may be made of 2-inch No. 1 clear cypress, all joints tongued and grooved or with slip tongue joint and the corners carefully rabbeted (Fig. 206). If desired it may be painted with a good oil paint down to the water line, but it is better not to paint below that point. Several styles of wooden tank may be obtained from dairy supply houses.

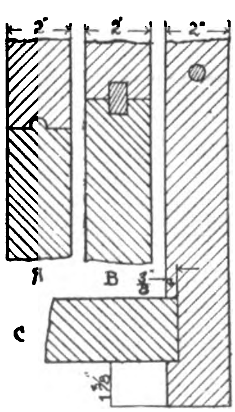



FIG. 206. Joint construction in wooden cooling tank. *a* and *b* tongue and groove; *c* rabbeted corner.

In many respects a tank made of concrete is the most satisfactory. If it is sunk into the floor so that only about a foot extends above

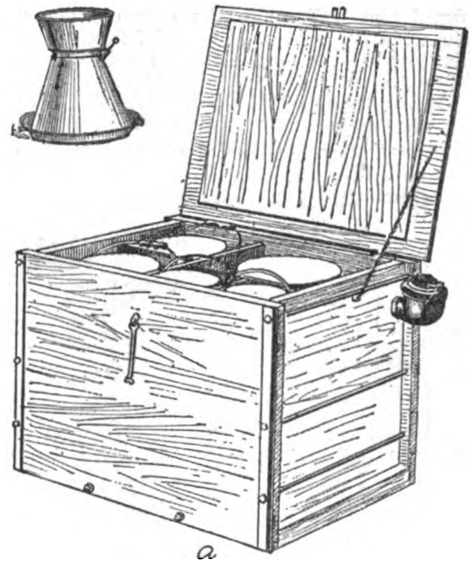



FIG. 207. Wooden cooling tank such as can be bought ready made or built at home. Inset shows popular conical metal cooler (see text below).

it, much labor in lifting the cans in and out will be saved. The top of the concrete should be faced with band or angle iron to protect it against wear in lifting the cans out and in, and there should be an outlet in the bottom so the tank can be easily cleaned, since more or less milk is sure to be spilled making the water foul and unfit for use.

Under some conditions a galvanized-iron tank which is cheap, quite durable and easy to keep clean, will give good results. Its chief disadvantage is the rapid loss of cold by radiation through the thin metal walls. In a more expensive, well-insulated metal tank built much like a refrigerator, there is very little loss of cold through radiation.

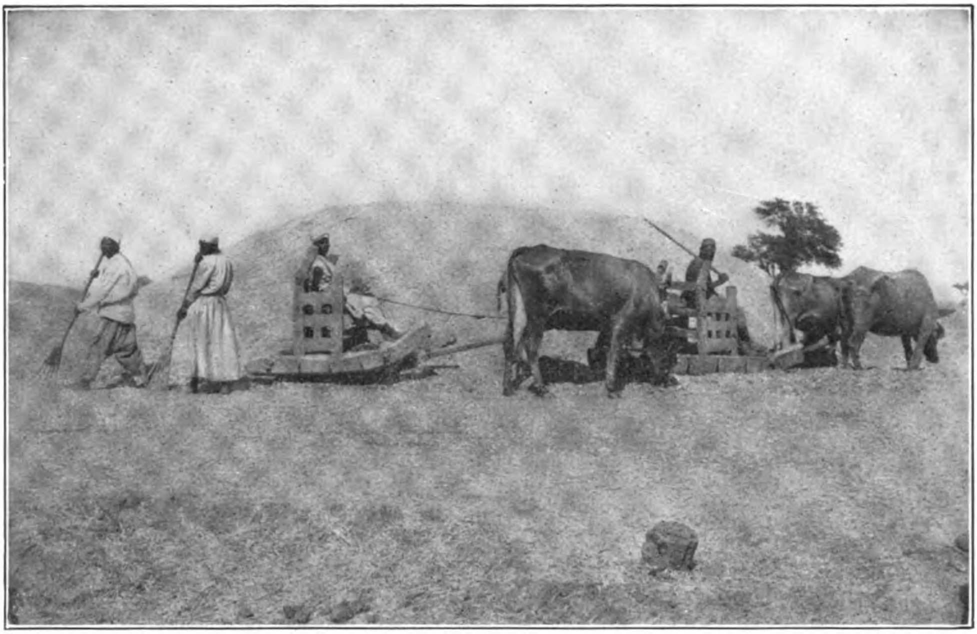
When milk is cooled in cans in any style of tank it is necessary to stir it frequently till the desired temperature is reached. This means added labor which is often a serious obstacle. When rapid cooling and less labor are desired, one of several forms of aërating coolers now on the market may be used. One of the simplest and cheapest is shown in Fig. 205. The open-topped conical drum may be filled with cold water or ice water or it may be connected to a running water supply by means of a piece of hose. When cold or ice water is used, it should be stirred frequently to prevent the layer next the cooling surface becoming warm. The milk tank, which rests on the cooling drum, has a circular row of fine holes at the base through which the milk flows, spreading out as it strikes the cooling drum, in a very thin, even film.

In the form shown in Fig. 205, running water

While the man works, the horses stand still; while they move his labor ceases. This is both a tiresome and an unprofitable method

With a spreader the operation is continuous and the distribution uniform; a maximum area is covered and with a minimum of human effort

THE TEST OF A SUCCESSFUL FARMER IS NOT HOW HARD HE WORKS BUT HOW MUCH HE ACCOMPLISHES ECONOMICALLY. WHAT GOOD ARE PROFITS IF ONE WEARS HIMSELF OUT IN SECURING THEM?



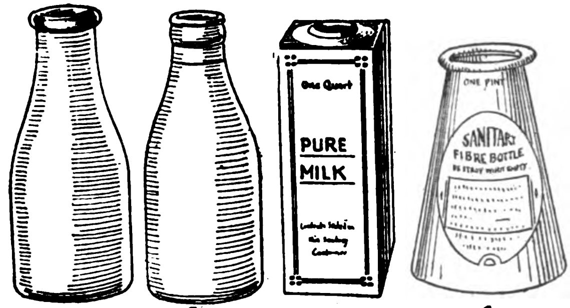
Threshing scene in Egypt, one of the few countries where native farming methods have remained unchanged for centuries

Threshing scene in our own wheat belt where science and practical experience combine to increase production and efficiency

FARMING GIVES MANY MEN A LIVING IN SPITE OF, RATHER THAN BECAUSE OF, THEIR METHODS. BUT THIS IS NO REASON FOR STICKING TO OBSOLETE, INEFFICIENT PRACTICES

enters at the bottom and circulates upward through the spiral coil till it reaches the overflow pipe at the top. The milk does not drip from one ring to the next but follows the entire surface, which becomes colder and colder toward the bottom. This cooler is made of copper heavily tinned both inside and out.

Where economy of space is important a very durable style of cooler shown in Vol. I Fig. 533 may be desirable. In this also running water enters at the bottom and flows out at the top; the milk flows in a thin film over the outer surface, the wavy construction giving a very long surface for the amount of space which the cooler occupies.



a b c d

FIG. 209. Common and uncommon containers for retailing milk

**MILK PASTEURIZER.** When it is desirable to pasteurize milk on farms, a tank of the style shown in Fig. 208 will be found convenient and satisfactory. With this it is possible to control the heating and holding temperature of the milk very accurately. The milk can also be cooled in this same tank by replacing the hot water with cold, or ice water. This pasteurizer is made in a number of sizes for handling different quantities of milk.

**MILK BOTTLE CASES AND DELIVERY BASKETS.** There are many styles of cases for carrying bottles on the delivery wagon. Some are made of wood with metal dividers, while others, entirely of metal, are somewhat more expensive but will outwear the wooden ones, and are also easier to keep in a clean and sanitary condition. When cracked ice is used on the milk during delivery, it is best to have cases with water-tight bottoms. When cracked ice is put over the bottles and the cover closed tight, the milk will remain at a low temperature for several hours even in hot weather.

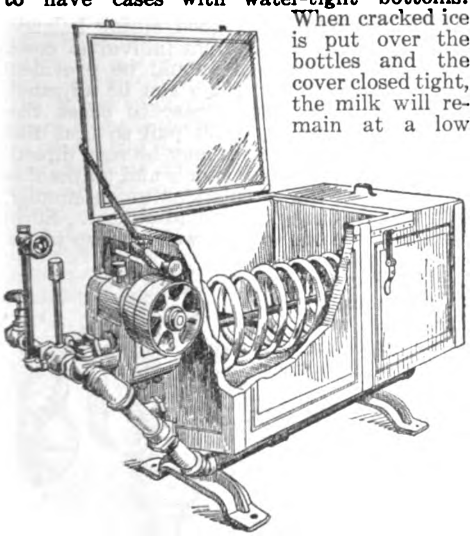


FIG. 208. Power-driven pasteurizer which may also be used as a cooler by running cold water or brine through the revolving spiral coil, instead of steam.

The dairyman who retails his milk needs some kind of a delivery basket or rack. One open wire style is very light but is well made and durable; another has a similar frame covered with a close mesh woven wire that makes it serviceable for carrying bottles of any size. A third style is made of tinned steel, heavier and able to stand much hard wear.

**MILK BOTTLES.** Most dairymen have their milk bottles made with some special identification mark, but aside from minor modifications, they are all made after one of the styles shown in Fig. 209. Any of the ordinary flat paper caps can be used with (*a*), while (*b*) requires the "beer-bottle" style of metal cap; (*c*) and (*d*) show 2 styles of individual service fibre milk bottles which, under certain conditions, are very desirable since they do away with all cost and trouble of collecting, washing, and sterilizing used bottles.

**MILK CANS FOR SEPARATING AND SHIPPING.** Among the different methods of raising cream by gravity, the Cooley-can system is generally recognized as the best. In the can used (Fig. 190*f*), the cover extends down over the sides forming a water-tight seal so that the can may be entirely submerged in cold water. A glass gauge on the side shows the depth of the cream. The skim-milk is drawn off from the bottom, the siphon preventing the cream from running out.

There are a few quite distinct types of shipping can aside from details of construction and size. The principal point of difference in the different styles is the form of the cover. Fig. 190*a* shows a can with flat top cover the edge of which extends well beyond the lip of the can thus protecting it from dust and dirt, and also the drop style of handle; (*b*) illustrates a style with hollow top cover and rigid strap handle; (*e*) shows a type in which the cover may be locked, closing the can air-tight, making it impossible to disturb the contents and preventing evaporation (this form is often desirable when cream is to be stored or shipped).

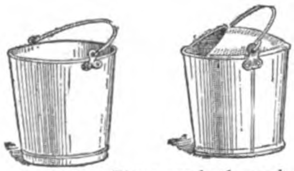


FIG. 210. These are both good pails, but the small-topped form is by far the better.

(*d*) shows an entirely different type fitted with a metal cap or plug attached by a short piece of chain, and commonly used in the New England milk districts for market milk.

Each of these styles is made in several sizes. The last one described usually holds 8½ quarts, the other 3 types are made to hold 20, 32, or 40 quarts.

A convenient can sometimes used for peddling milk from a wagon has a 1-quart measure for a cover (Fig. 190*c*). This arrangement protects not only the milk can but also the measure from contamination with dust and dirt while on the route.

**MILK PAILS.** The milk pail is an important factor in determining the sanitary quality and the market value of milk. A good milk pail should (1) be easy to use; (2) be durable; (3) be easy to keep clean; and (4) as far as possible, prevent the entrance of dust and bacteria into the milk.

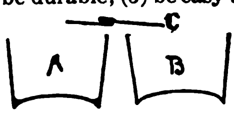



FIG. 211. Good (*A*) and poor (*B* and *C*) seam construction in dairy tinware.

To meet the first requirement a pail must be of the right form and size to hold easily between the knees and below the level of the cow's udder. For most men a 12-quart pail of the form shown in Fig. 210 is the most desirable; if too flaring it is difficult to hold, and if too high it is inconvenient to use.

To meet the second need the pail must be made of metal, heavy enough to stand use without binding or denting. Pails made from heavy tin, well reinforced at top and bottom either with band iron or wire, are good and the lowest in price. A galvanized iron bottom adds somewhat to the cost, but a pail so strengthened will wear much longer and in the end be just as cheap. Pails made of heavy, pressed steel, well tinned inside and out, are strong and durable, greatly outwear the thinner ones, and on many farms are giving excellent results.

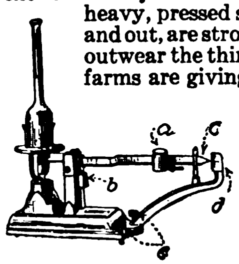



FIG. 212. Scales for use in testing dairy products. *a* sliding poise; *b* hanging poise; *c* pointer beam; *d* indicator plate; *e* levelling screws. (See text p. 134.)

Because of the great importance of cleanliness only metal pails should be used. Furthermore, there should be no open seams or cracks into which milk can get and which can not be easily reached with the wash cloth or brush. All seams and corners should be well flushed with solder as shown in a Fig. 211; such conditions as are shown in *B* and *C* should never be allowed in pails or other utensils used for handling milk. From the point of ease in cleaning, pails made of pressed metal without seams are especially desirable.

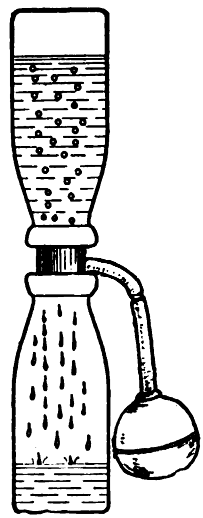


FIG. 213. Diagram to show action of sediment tester.

Keeping quality is a very important factor in the market value of milk, and since keeping quality is largely dependent upon the number of bacteria in it, it is desirable that as many as possible be prevented from entering the milk. Many of the bacteria in fresh milk fall in from the body and udder of the cow during milking, hence it is important to use a pail made to keep out as many as possible of these organisms. A hooded or covered pail (Fig. 210) is very desirable for this purpose, being easy to use and able to exclude approximately two thirds of the bacteria which would fall into an ordinary pail. The crown in the hood makes every part of the inner surface visible and easy to wash. A covered pail costs a little more than the ordinary sort, but the hood adds stiffness and makes it wear longer.

**MILK SCALES.** A good spring balance for weighing the milk from individual cows when records are kept should be provided with a loose pointer which can be adjusted by means of a thumbscrew to offset the weight of the empty milk pail so that the exact weight of the milk may be read direct. The scale that reads in pounds and tenths of a pound makes the calculations much simpler than one showing pounds and ounces. Such a balance is made in sizes weighing up to 30 and 60 pounds respectively. For weighing milk in cans, a platform scale with the beam graduated to half pounds is desirable.

**MILK SEDIMENT TESTERS.** The amount of insoluble dirt in a particular lot of milk may be ascertained by the use of a sediment tester of which there are several styles on

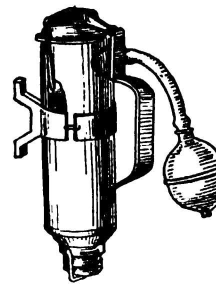


FIG. 214. Metal type of sediment tester

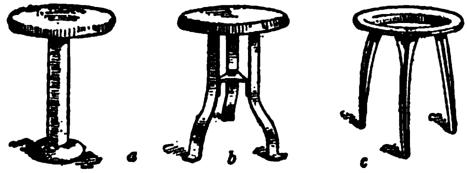


FIG. 215. Sanitary metal milk stools. (See text)

the market. In using one of the cheapest and simplest, a pint bottle is filled with the milk to be tested; the tester containing a disk of filter cotton is placed over it then turned upside down over a second, empty pint bottle. A few squeezes of the bulb give enough pressure to force the milk through very quickly (Fig 213).

In another style (Fig. 214) the cotton filter is easily clamped in place on the bottom, the chamber filled with milk, the air-tight cover clamped on and the required pressure obtained by means of the bulb. This may be used as a portable tester by the milk inspector or, in the factory or creamery, may be attached by means of the bracket over the weigh-can for testing the milk of different farmers as their milk is received.

A style of filter is made for use where a large number of samples are to be tested. A number of filter tubes are placed in a hot-water jacket which hastens the filtering process, especially in cold weather. Each of these devices uses a standard 1-inch filter disc, and holds a pint of milk.

**MILK STOOLS.** The usual wooden milk stool soon becomes very dirty, is not easily cleaned, and is usually quite short-lived. To meet the present day demand for a more permanent stool which could be kept clean, the stools shown in Fig. 215 have been placed on the market and are now in use on many dairy farms: *a* is a single-piece stool, the seat, leg, and foot being welded together and the entire stool then given a heavy enamel coating, making the surface smooth and easy to wash and keep clean; *b* is of the same size, but has 3 legs which are securely riveted to the seat and stiffened by a brace about half way down; the whole stool is then heavily enameled making it practically a one-piece stool; *c* is made of malleable iron cast in one piece, galvanized, and very strong and durable.

**MILK STRAINERS.** Whatever differences exist in different methods of handling milk, one operation is rarely omitted—that of straining. Of the many forms of strainers on the market, many are too complicated for practical use. A good strainer should be simple in structure, easy to use and capable of removing all particles of dirt. Fig. 216*a* shows one of the simplest and cheapest styles. The one or more layers of strainer cloth are placed over the bottom of the cylinder and held in place when the loose collar is pressed into place. In another type (Fig. 216*b*) the milk passes through 2 layers of metal gauze of different mesh which are held in place by a wire spring, and can easily be removed for washing. If a heavier, more durable strainer is desired, the one shown in Fig. 216*c* in which the milk passes through 2 sets of strainers will give good results. It is made of heavy tin, each section being a single seamless piece.

FIG. 217. Complete two-cow unit of one type of mechanical milker.

**MILKING MACHINES.** Since about 1910, a number of different styles of milking machines have been placed upon the market. In this development, many manufacturers have endeavored to imitate the action of either the calf or the hand milker. In all the machines, the milk is drawn from the teat by the creation of a vacuum in the teat cup, or by pressure outside, or by the combined action of a vacuum in the teat cup and pressure applied to the side of the teat. Some of the chief differences between machines now on the market are in the form of the teat cups and in the principle by which they work. On this basis there seem to be 3 general types. In one the teat cup consists of a rigid metal cone with a flexible rubber cup at the top, which forms a close ring around the teat. The body of this teat cup is not flexible and has no inner lining; the milk is drawn by creating alternately a vacuum and a normal atmospheric pressure in the cup. This form of cup is made in 3 sizes to fit cows with large, medium, and small teats. It is shown on the machine in Fig. 217.

In a second type of cup, (Fig. 218), the outer wall is rigid but there is an inner flexible lining. The milk is drawn by creating first a vacuum in the inner tube and then pressure in the space between the inner lining and the outer wall, which exerts a squeezing effect [upon the teat. This action, in which the periods of the vacuum and pressure alternate automatically, is supposed to have the effect of preventing the accumulation of blood in the blood vessels of the teat.

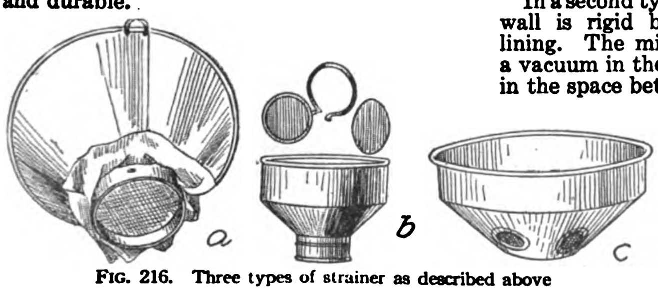


FIG. 216. Three types of strainer as described above

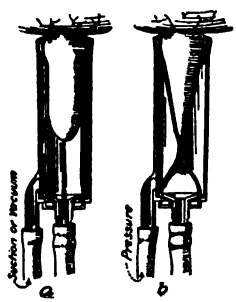



FIG. 218. How teat cups of the second type (p. 141) work.

The third type of cup (Fig. 219) also has a double wall. One side of the outer wall is rigid while the opposite one is soft and flexible, the flexibility being greatest at the top. When the vacuum is applied, the soft side is drawn in, causing pressure on the teat first at the top and gradually extending downward. This pressure is intended to imitate the action of the hand in hand milking.

Many variations of these types are found in the machines now on the market.

For creating and controlling the vacuum and air pressure, many devices have been developed but as in the case of the teat cups, there appear to be three general types after which the other makes are patterned. In one of these (Fig. 217), the automatic control is placed upon the cover of the milk pail, and is operated by means of a vacuum pump connected with the air pipe line placed over the cow stanchion. This regulator or "pulsator" is automatic and can be adjusted to give any desired number of strokes per minute; it is easily removed from the pail for cleaning and sterilizing. In this form of milker, there is continuous vacuum in the pail which seals it tight and avoids any possibility of the cover falling off during the milking process.

A second type of pulsator (Fig. 220*a*), instead of being attached to the milk pail, is applied at the pipe line above the stanchion, and is operated by compressed air. It requires the use of 2 rubber tubes from pulsator to milk pail and also from the pail to the teat cups instead of one tube as in the case of the first style. This pulsator does not come in contact with the milk and therefore requires no washing; it also maintains a constant vacuum in the pail which seals down the cover.

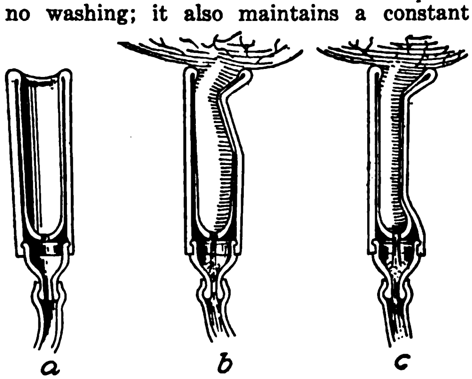



FIG. 219. Three stages in the operatio of the third type of teat cup

In the third type (Fig. 220*b*) the vacuum is created only in the tube system so the cover of the pail is not sealed down during the milking. The vacuum and release in the teat cups are caused by the alternate opening and closing of the valve at the bottom of the vacuum chamber in the lid of the pail. Like the other styles, this machine is operated by means of a vacuum pump and some means of power which may be located at any convenient place, outlets for the attachments of the rubber tubes being distributed along the pipe line above or beside the stanchions.

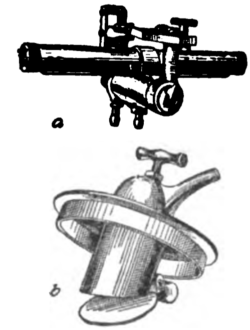
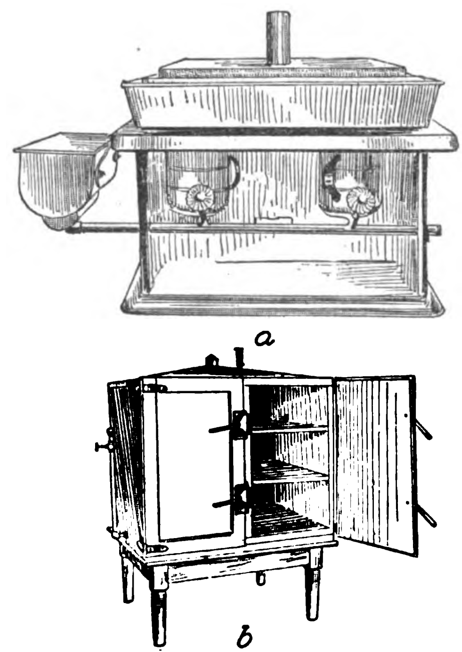



FIG. 220. Pulsating mechanism of two types of milkers. *a* is attached to pipe line, *b* forms cover of the pail.

**STERILIZERS.** In the handling of milk and other dairy products, nothing is more important than the thorough sterilizing of all the utensils. In the case of a few utensils this may be done by thorough scalding with boiling water or by submerging them in boiling water. If there are many, the use of steam will be more satisfactory, both from




IG. 221. Two sterilizers suitable for house and farm use, described on the following page

the standpoint of complete sterilization and the saving of labor. On many dairy farms large wooden chests or chambers built of concrete or hollow tile are giving excellent results. Fig. 221*a* shows a small sterilizer devised by the U. S. Department of Agriculture (see Farmers' Bulletin 748) for use over a 2-burner oil stove in small dairies, and which can be made by any good local tinner. A galvanized iron box confines the steam generated from water held in an ordinary roasting pan, the steam then escaping through the tube on top. Pails and cans are sterilized by being inverted over this exhaust pipe.

Where a supply of steam is available the heavy galvanized iron sterilizer (Fig. 221*b*), in which the steam enters through perforated pipes in the bottom makes a very useful sterilizer, since all the utensils used during the day can be treated at once. When the steam is turned off the door should be opened for a few minutes to allow the steam to escape so the utensils can dry off. They can then be placed on racks or left in the sterilizer till needed for use. Larger, higher grade machines, insulated and filled with loose shelves, trucks and metal rails, drainage devices, etc., are made for use in large dairies.

**WASH SINKS AND BOTTLE WASHERS.** A good wash sink is a very important part of the dairy equipment. The old-style wooden sink is hard to keep clean and is being rapidly replaced by the metal tank type. A round-bottomed sink is especially good for washing milk cans. If it contains a centre partition, one side can be used for washing and the other for rinsing. Such a tank costs somewhat more, but really serves as two sinks, and is very economical and serviceable.

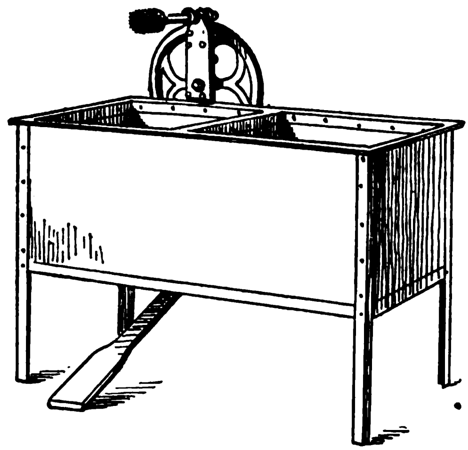


FIG. 222. A good metal double wash sink with bottle brush operated by a foot treadle

A small number of bottles may easily be washed with a regulation bottle brush, but if 100 or more are to be handled daily a foot power-washer (Fig. 222) will be a great time saver. For still larger numbers of bottles a power-driven washer run by steam turbine, belt, or electric power, is desirable.

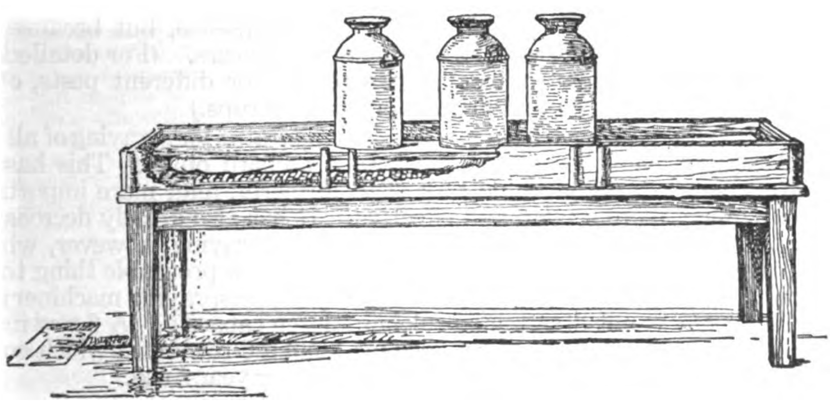


FIG. 223. Farm-made apparatus for pressing cheese (see p. 135)

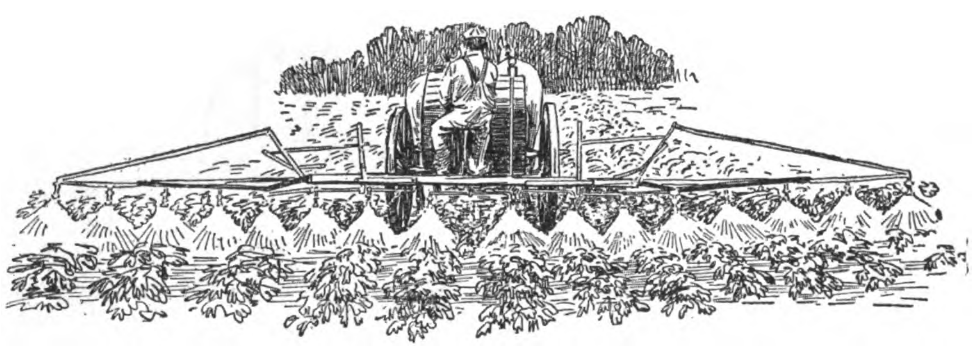


FIG. 224. A triumph of modern invention in spray machinery. A horse-drawn, engine-driven machine covering twelve rows with sixteen nozzles

# CHAPTER 13

# Machines for Spraying Crops

*By* F. F. ROCKWELL, *(see Chapter 11). The greatest development of spraying apparatus has been along the lines of vegetable and fruit growing activities, and it is these to which Mr. Rockwell has given a large share of his attention. As in the case of the garden implements he describes in an earlier chapter, his statements and recommendations are invariably based on personal practical trials and experiences. That he is equipped to put his ideas in interesting, convincing form has already been proved by his books which include "Around the Year in the Garden," "The Key to the Land," "Vegetable Gardening," "Gardening Indoors and Under Glass," and others.*—EDITOR.

SPRAYING has become, during recent years, an acknowledged factor in the successful culture of many of the most important crops of the farm, garden, and orchard. Many of the large growers would sooner think of attempting to get along without their harrows or cultivators than without their spraying apparatus. Spraying is coming into such universal use, not only because it is a protection against possible loss from insects and disease, but because it *increases profits,* in normal as well as in exceptional years. (For detailed directions as to when and how to spray, what to use for different pests, etc., see Vol. II, Chapters 32, 33, 34 and articles on special crops.)

Wonderful advances have been made in the apparatus for spraying of all kinds, from the smallest hand sprayer to the largest orchard outfit. This has made spraying a much less disagreeable task than formerly, and, more important, it has made it much more certain and effective. It has also greatly decreased the cost of applying the spray material. The cost of spraying, however, which is, after all, the factor which will determine whether it is a profitable thing to do or not, will depend very directly upon the efficiency of the spraying machinery used. Further, efficiency is not determined solely by large capacity. A 2-row machine which *will keep working* will be cheaper to use than a 6-row outfit which continuously gives trouble and has to be replaced after a few years' use.

The requisites of a good spraying machine, of no matter what type, are as follows: reliability, good pressure, accessibility, convenience, and facility of repairs.

**Reliability.** This point, important with any machinery, is relatively more important in the case of the sprayer than with most other farm machines. The results of the work done, the cost of applying the spray, and the completion of the work *on time*—which is more important in spraying than in almost any other farm operation—depend directly upon reliability, upon having a machine so practical in design that it will *keep working.*

**Good pressure.** The results of spraying depend directly upon the thoroughness with which the work is done. A steady, high pressure that will break the spray up into a fine mist, reaching every part, penetrating crevices, and adhering when larger drops of the spray would merely strike and roll off or run together, is absolutely essential for good work. A constant, *even* pressure, as well as high pressure, is of equal importance.

**Accessibility.** The best of pumps will have to be cleaned and regulated occasionally, and will sometimes need repairs. Construction or design which will admit of such work being done quickly and easily is of great importance. A sprayer that requires a machine-shop equipment to get at its interior is not a good pump to have to depend upon. The working parts should not be made accessible, however, at the cost of risk either to the operator or to the machinery. Working gears and so forth should be inclosed or protected by guards so that they will be "fool-proof"; and the whole apparatus should be protected by screens, side curtains, or similar guards to prevent the possibility of limbs, broken-off twigs and so forth from getting caught in any of the working parts.

**Convenience.** Time is an important element in spraying, because it affects not only the cost, but also the results, of the work. A spraying equipment should be such that the work can be done as expeditiously as possible. Small things count. A hinged tower that can be folded down, instead of a rigid one; an equipment of tools on the spray rig for making all adjustments and slight repairs; angle or other special nozzles carried *with* the outfit; a rig that will turn short, but with the centre of gravity low down, so that there is no danger of tipping over; an adequate supply of such extra parts as are most likely to wear out or give way, such as washers, gaskets, hose connections, and so forth; in a power machine, a good, reliable engine; a tank that can be conveniently filled, but will not slop over when it is full—all these things, and many others, are minor points perhaps; but in the aggregate they make a

FIG. 225. Spraying melon vines with double nozzles on two lines of hose, the machine being of the horse-driven traction type.

great deal of difference in the actual efficiency of the outfit in use; and they should be borne in mind when selecting a machine.

**Repairs.** After determining the type of machine best suited to your purposes, get the best of that kind there is to be had. You may find a wide range in prices, but in spraying equipment, if anywhere, "the best is the cheapest." Many of the materials used in spraying are highly corrosive. A brass tank or brass working parts may be more expensive than those of some other metal, but the additional expense will pay in the long run, because the weakest part of the machine will be the one to determine its working life.

Good modern spray machinery is made to give long, reliable service without constant tinkering and repairing. When it finally gives out it is generally worn out and should be replaced. But even a good machine sometimes needs repairs in a hurry. It is well to buy your equipment, therefore, from an established concern from which you can always get advice or repair parts without any trouble. Other things being equal, buy the machine for which you can get this service in the shortest possible time.

These general principles apply to all spraying equipment, and should be taken into consideration when one is making a selection of any kind of spraying apparatus, from a hand syringe to a high-powered orchard outfit.

## General Types of Sprayers

With the very wide variations that exist in the forms, sizes, and mechanical construction of pumps for many different purposes, the simplest basis on which to make a classification of the different kinds of pumps is the kind of power by which they are operated. There are three general types: those worked by hand power; those driven by traction from the wheels of the rig on which they are mounted; and those driven by engine power.

The power-driven outfits are, of course, the most expensive, but their capacity is so much greater that they are coming into more and more general use, even for those purposes for which the other two types have been generally used. The traction type has the disadvantage of being more uneven in the pressure supplied than either of the other two, and it is on the whole more likely to get out of order.

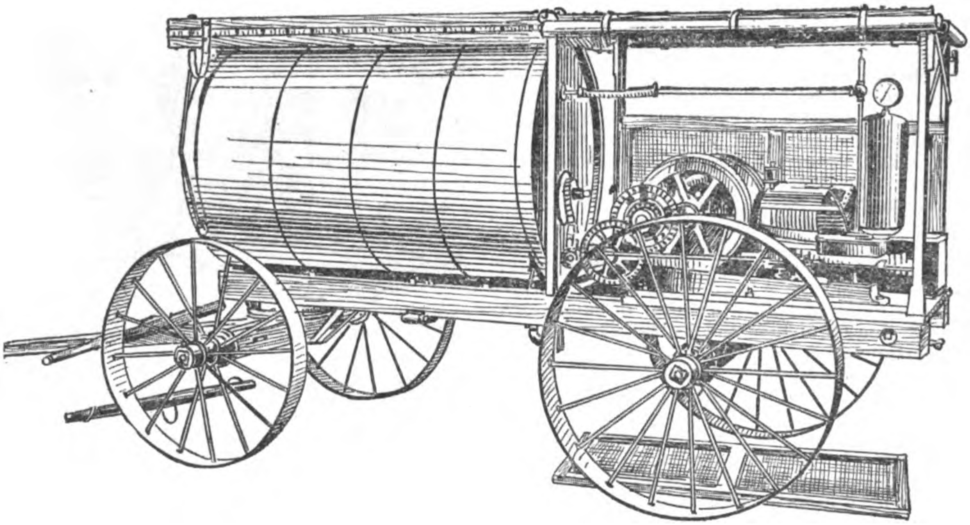


FIG. 226. A power sprayer suitable, and indeed essential, for large commercial orcharding operations. A tower can be erected on it for reaching tall trees

Frequently outfits of this type cannot be used under unfavorable conditions, such as on wet ground or over steep grades, where either of the other types could be used. Where, as is usually the case, there is a good deal of other work for a small engine on the farm, the spraying-outfit engine can be used for that purpose and need not be charged up entirely to the spraying equipment.

The disadvantage of the hand-operated pump, compared with either the traction- or the power-driven type is, of course, that it is either very limited in capacity or will require the services of an extra man in addition to the applying of the spray material. The larger hand outfit now, however, is entirely practical and good for commercial work, where the amount of spraying done is not too great. It can be utilized for many purposes, being readily adapted for work in the orchard, on garden or field crops of limited area, and for spraying, disinfecting, and so forth.

Another general distinction among pumps of various kinds is based on the manner in which the spray material is applied—whether by compressed air or directly by the force of the pump. The former method is more flexible and gives a more constant and even pressure; and it is under more accurate control, with less danger of breakage, if anything goes wrong. Both types, however, are used successfully, and neither is best for all purposes. In small hand sprayers, the compressed-air type has the advantage of allowing the pumping to be done in advance of the actual spraying, so that one's whole attention can be given to the latter while the material is being applied.

## Outfits for Orchard Spraying

Orcharding, like the growing of any other commercial crop, is being done on a larger and larger scale. Spraying in commercial orchards is done mostly by power-driven outfits of 100 to 250 gallons capacity. The size of the orchard is not the only factor in determining which size of tank will be the most economical to use. On hilly or rough land, a tank of relatively small capacity, when full, may be all that a pair of horses can handle. Here, as in selecting the make of your machine, it is important to get one that will *keep working*. Delays and

breakdowns are expensive; and the bigger the machine, the more expensive they are.

Where spraying is one of the important operations on the farm, it will pay to have the spraying rig complete in itself, rather than to have to depend on using another wagon gear. Spraying outfits can be bought, however, that are mounted on a substantial base, ready to use on a farm gear, where that seems desirable. One of the handiest outfits for a moderate-sized orchard is a small engine pump and tank mounted as a unit on a platform which can be slipped in to a suitable farm wagon, or placed upon a flat truck. Some of these outfits are designed to work without even being secured to the wagon in any way; but, of course, bolts or lag-screws, to prevent possible slipping on hillsides or rough ground, will be only a reasonable precaution. Such outfits may be had to carry 50 to 100 gallons of spray, and weighing, complete, 500 to 700 pounds. An outfit of this kind, especially if there is available a suitable place to store it during the periods when it is not in use, so that when wanted it may be let down on the wagon body by means of a block and tackle, makes an ideal 1- or 2-man outfit for the small orchard. While it costs a little more than a hand pump and a barrel outfit for a wagon or cart, it has several times the capacity, will save one man's time, and is thoroughly practical in every way.

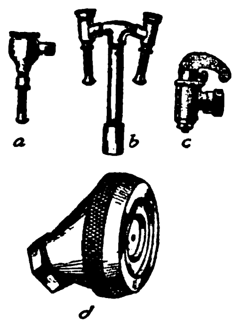


FIG. 227. Popular types of nozzles: *a* and *b* single and double Vermorels; *c* bordeaux; *d* a recent improved development.

For the home orchard or the small commercial orchard of only a few trees or few acres, where it is often operated in connection with poultry or intensive truck gardening, a barrel-pump sprayer is the most economical and will answer its purpose. One of the objections to this type of sprayer is that the small quantity of material carried makes it necessary to come back to the base of supplies very frequently. Even when only a 1-horse cart or wagon is used for transporting the spray outfit, much of this wasted time may be saved by carrying 1 or 2 extra barrels of the spray material with tight covers along with the barrel with which the spraying is being done. When this extra supply is needed, it can be simply siphoned into the barrel into which the pump of the spraying outfit is attached, care being taken, of course, to keep it agitated while it is being drawn off, so that the mixture will remain uniform. With an outfit of this kind, at a very low, initial cost, two men will cover a great many trees in a day's work.

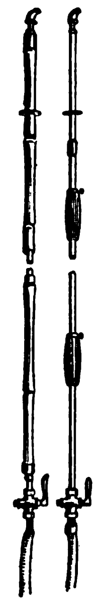


FIG. 228. Extension rods for orchard spraying, one of bamboo, the other of metal with sliding grips

**Equipment for orchard work.** The larger spraying outfits are usually equipped with an elevated platform or stage with a substantial railing around it, to enable the men who are handling the hose to be in a better position to do their work, to reach the tops of tall trees, and to save spray material. Under some conditions, however, the spray tower may not be needed, or may even be in the way. It should be easily removable, and, in the most convenient type of apparatus, it is hinged on one side, so that it may be folded over for going under large limbs or wires on the road, farm gateways, and so forth.

One of the most frequent causes of annoying, awkward, and costly delays in spraying is worn-out or dried-out hose and hose connections. An ample supply of all the minor repair accessories—hose fittings, washers, connections with bands, etc.—should be carried along with the machine. Also, a lead of hose should be kept available in case of accident. With the high pressure used,

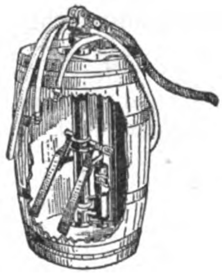


FIG. 229. Barrel spray pump, an excellent all-round farm outfit, partly cut away to show agitators

and the strenuous treatment necessary in spraying, one can never be sure when a hose is going to "go."

For most orchard work, extension poles for use in connection with the hose are required. These are made either of steel or of bamboo with an inner tube. The former, with adjustable wooden hand grips, are coming into more general use. Drip guards, formerly used and recommended for the operator's comfort are being rendered unnecessary by improved pole construction and materials. Special strainers for filling the tanks may be had for most outfits and are well worth their price in time saved both in excluding foreign matter from the tank and in preventing clogging of the nozzles. Where there are large acreages to be taken care of, a pump for filling the tank will be a paying investment; for even a slight delay at each trip, this point will cut down the day's work from a tankful to several tankfuls.

A new system in orchard work uses a nozzle which throws one big sheet of mist for 15 feet or more, so that fruit trees of ordinary size may be covered clear to the top branches from the ground. It enables one man to apply as much spray as two or three could with the ordinary pole-and-small-nozzle equipment. A good-sized tree can be covered in half a minute. The spray "guns" may be used singly or in pairs, and if desired, in connection with the regular spraying apparatus. Any one interested in getting a new orchard outfit would do well to investigate this new system and, if possible, to see it in actual operation before he decides to purchase the standard spray equipment.

Another type of the power sprayer for orchard work is the compressed air sprayer in which *only the air* is carried with the outfit, the engine and compressor being located at the central point, where the tank is filled. Where it is possible to get air under sufficient compression without going to too great an expense, this system has some advantages, especially in very hilly orchards, or where the work is being done on a very large scale. The weight of the outfit to be transported is, of course, very much reduced, and therefore more of the spray material can be carried. The danger of breakdown or injury to the equipment in operation is also much less. The equipment, if used, should be such as to make it possible to keep up the pressure required for good work until all the contents of the tank are emptied—a petering out of air pressure means poor results. Under the right conditions, the work done is as good as by the regular equipment. It is merely a question of which will pay the best, and that depends principally on local factors.

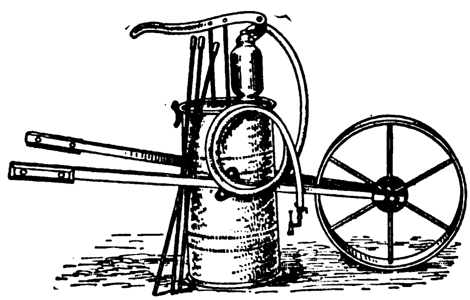


FIG. 230. Wheelbarrow type of hand sprayer suitable for whitewashing as well as crop spraying. Tank can be removed and barrow part used for other farm work

## Spraying Equipment for Small Fruits and Field Crops

For spraying field crops, small fruits, vineyards, and so forth, the traction type of sprayer is used more generally than either the engine-driven or the hand-power type. Spraying of this kind can be done automatically at a uniform rate of speed, and the traction-power is, therefore, sufficiently steady to answer the purpose. With machines of greater capacity, and the recognized necessity of using high pressure to get a mist spray, traction as a source of power becomes less practical and is being gradually replaced by lightweight but highly efficient gasoline engines.

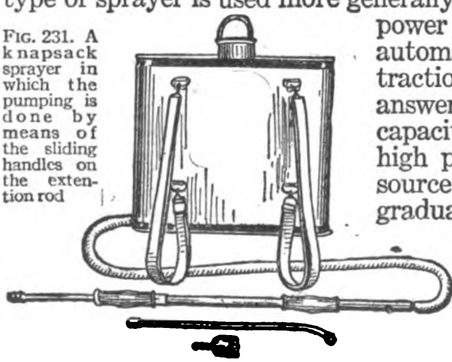


FIG. 231. A knapsack sprayer in which the pumping is done by means of the sliding handles on the extention rod

Much of what has been said in regard to orchard outfits applies to the equipment for field sprayers. The main things in selecting a pump for this purpose,

are to make sure that you are getting a practical, substantial pump, and to obtain an equipment in the way of spray arms, nozzles, and so forth, that will be exactly suited for the purpose for which you wish to use it. In this connection, it should be kept in mind that for most crops it has proved most effective so to concentrate the nozzle fire that it will strike the row or crops from the side or even at an upward angle as well as from the top. This is especially true in the case of fungous diseases and of such insects as the melon louse, which congregate on the under surfaces of the foliage. With the increased pressure obtained in using an engine-driven sprayer for field work, however, resulting in a fine spray or mist that completely envelops the plant, it is not so necessary to have part of the nozzles arranged for going sideways or at an upward angle. In fact, in the latest type of power field sprayers, there is no attempt to hit the individual rows with the spray. The nozzles are so arranged that the entire area covered, some 25 feet in width, receives a dense, foggy spray under high pressure which penetrates to all parts of the plant (see Fig. 224). The engine upon this machine may be used to operate other portable farm machines such as potato diggers, binders, etc. There is little doubt that the power sprayer will replace the traction sprayer for field operations, where planting is done on a large scale.

Fig. 232. A convenient and popular knapsack sprayer—

Fig. 233. To which an extension rod can be attached for spraying small trees or the under surface of leaves.

**Hand-power sprayers.** The hand-power sprayers, while not practical for work on a large scale, are, however, of the greatest use for taking care of small patches of truck of various kinds, garden crops, and fruit trees, for home use, and the spraying and disinfecting of animals and buildings. A small hand sprayer has its place in the regular equipment of practically every farm. Unfortunately, such poor care is taken of these small machines that usually they wear out within a few years, not from use, but from neglect.

There are, in general, 4 types of these small sprayers: (1) the bucket or ordinary force or suction pumps; (2) the barrel sprayers which are very similar, on a little larger scale, but are of large enough capacity to be of practical use for commercial field crops or for orchards of small acreage; (3) the knapsack sprayers, which, while of small capacity, are readily portable and are useful in small market gardens and about the place generally; and (4) compressed-air sprayers, which cover the same field as the knapsack type, but are, in many ways, more convenient, as they are easier to carry, will not slop over, and furnish a spray under higher pressure more completely under the control of the operator.

A more recent modification of the barrel type is the small portable tank sprayer, which has as wide a range of use as the knapsack and compressed-air types with a much greater capacity. This type has proved the efficiency of its work and become popular very rapidly. It fills a long-existent definite need of the smaller grower, who has wanted a sprayer that could be transported conveniently by hand and yet have enough capacity to be of practical use for commercial work. Some sprayers of this type have been equipped with traction drives from the front wheel and, under good conditions, are practical for field work.

For the very small place, for use in the greenhouse and frames, and where a few hens, or a cow or two are kept, the simple small hand sprayer, with glass or brass tanks, with a capacity for a quart or so of spray material are of real service; with these, as with any spraying equipment, however, it decidedly pays to get the best. There are very many of these small sprayers on the market, very flimsily made of tin

Fig. 234. With a good pump and nozzle the bucket outfit is satisfactory for work on a small scale.

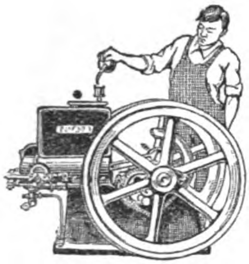
Fig. 235. The smallest type of outdoor sprayer for either wet or dry preparations.

and solder that will go to pieces almost before you can get them home from the store. There are a few, however, that are more substantially made, and, if used with care, will give years of service. They will cost two or three times as much as the makeshift affairs that are usually offered for sale, but are well worth not only the difference in price, but any trouble one may have in hunting them up when one is ready to buy. The best of these sprayers have 2 nozzles, with one of which the under sides of the leaves of vegetables or ornamental plants may be reached. It is often worth while to have a little sprayer of this kind on hand, even on a large place, for occasional use and to give prompt attention to the first insects which may appear before it would pay to spray the entire crop. Around the lawns and borders such an implement is especially effective since even the children can operate it. By keeping flowers, vines, and shrubs free from insects and disease one gives added protection to the farm crops as well.

## Equipment for Dusting or Dry-Spraying

Within the last few years, the application of spray materials in the form of dust or powder has been developed very considerably and is now being used by many large commercial growers in place of the wet sprays. The saving in transportation, and in the application of these spray materials is, of course, very considerable. The gains now being made by this method, in actual field practice, are due both to the advances in the chemical preparation of the spray material, and to the equipment for applying it. It is perhaps too early to predict that the dry or dust sprays will replace wet spraying to any great extent, but such may quite possibly be the case. In orchard work the dust spray has, in many instances, proved as satisfactory as the wet, in controlling the codlin moth; in general it has been less successful against scab. As late as 1918 the cost of dust spraying was considerably the larger. Any one who is buying new spraying equipment will do well to investigate carefully the possibilities of this method for the crops and the conditions he has to deal with. Many of those who have changed to the dry system seem to feel that they are getting just as good crop protection as formerly at very considerably less cost per acre. The principle, of course, is not new, and this kind of spraying has given good results on small areas for many years.

Fig. 236. Four-row traction dust spray machine, convenient and highly efficient under certain conditions



# FARM KNOWLEDGE

## PART III

# Power on the Farm

IN 1915, after a careful investigation, an engineering authority of national prominence estimated that the power supplied by horses, mules, windmills, steam and gas tractors, and gas engines on farms amounted to 23,905,000 horsepower. This total, compared with figures taken from the last census, represents 5,149,714 more horsepower than was then being used by all the manufacturing enterprises in the country! This suggests what power on the farm means. Yet it is only a partial suggestion, for, in the first place, it leaves out all water- and electrical-power plants; and, in the second place, the use of power on farms has increased tremendously even since the above estimate was made.

The chapters that make up this part of Farm Knowledge undertake to explain some of the principles of power and its application to farm needs; and also to describe some of the means by which it can be created and utilized to increase the farmer's efficiency, his productive ability, and his chances for success. What he has already done in this direction has helped greatly to increase the Nation's per capita productions of staple crops, sufficiently, indeed, to balance the steady decrease in the number of persons engaged in agriculture.

Yet even more may confidently be expected in the future. Dr. B. T. Galloway, of the U. S. Department of Agriculture, once said: "The farm of the future will so utilize modern labor-saving devices and efficiency methods that human labor will be reduced to a minimum and the farmer and his children will have time and opportunity for and means of living a satisfactory life." Perhaps the following verses, published in the *Kansas City Star*, will ere long express as much of truth as they originally did of humor, and refer as accurately to other sources of power as they do to the undeniably versatile tractor.—EDITOR.

The tractor on the farm arose
  Before the dawn at four;
It milked the cows and washed the clothes,
  And finished every chore.

Then forth it went into the field
  Just at the break of day;
It reaped and threshed the golden grain
  And hauled it all away.

It plowed the field that afternoon,
  And when the job was through,
It hummed a pleasant little tune
  And churned the butter, too:

And pumped the water for the stock,
  And ground a crib of corn;
And hauled the baby round the block
  To still its cries forlorn.

Thus ran the busy hours away,
  By many a labor blest;
And yet when fell the twilight gray
  That tractor had no rest.

For while the farmer, peaceful-eyed,
  Read by the tungsten glow,
The patient tractor stood outside
  And ran the dynamo.

CHAPTER 14

# Power and Power Machinery on the Farm

*By* R. P. CLARKSON, *Professor of Engineering, Acadia University, Nova Scotia, since 1912, and before that, Assistant Manager, Worcester (Mass.) Boiler Works; Designer of Special Machinery, United Shoe Machinery Co.; Instructor in Mechanical Engineering, University of Vermont; Examiner of Patents and Electrical Engineering Expert for the U. S. Government; and Consulting Engineer of various engineering projects, agricultural and otherwise, in Canada and the United States. Notwithstanding this extensive experience along technical engineering lines, Professor Clarkson has given much time to the study of the application of mechanical and engineering principles and methods to practical agriculture. He has spent a good many summers on farms and for a number of years has answered engineering inquiries from readers for the "Rural New Yorker." He has also contributed many papers to other farm journals and is the author of "Practical Talks on Farm Engineering."* Consequently his contributions to "Farm Knowledge" reflect an understanding of just what farmers want to know and in just what form they want to have their questions, answers or unfamiliar subjects presented to them.*—EDITOR.

## Some Mechanical Terms and What They Mean

SUCH terms as energy, work, and power are so frequently used in the following chapters that a brief statement of their exact meaning is necessary.

**Energy** is capacity for work or ability to do work. Coal has stored-up energy—capacity for doing work by heating water and changing it to steam by means of which huge engines may be operated. Gasoline, gunpowder, dynamite, the wound-up spring of an alarm clock—all have the same stored-up energy ready for use when released. This type of energy is called *potential energy*, the term "potential" in this connection having exactly the same meaning as when we speak of "potential" life in the tiny seeds or the "potential" value of a great organization or a great idea.

On the other hand, the falling weight of a pile driver, the cannon ball flying rapidly through the air, the kick of a mule, the wind and the swiftly rushing stream all have energy due to motion. They represent tremendous forces—not stored up, but actually being exerted. This is *kinetic energy*. All potential energy must become kinetic before it can be utilized, just as a gold dollar must be spent before it is of real value. Stored in the pocketbook it represents "potential" buying energy, but it cannot purchase anything until actually put into circulation.

**Work** is done only by expending energy. Lifting a weight, hauling a loaded cart, the action of the brakes in bringing an automobile to a stop, the action of steam or of the gasoline explosion on an engine piston—each of these represents the effect of a force acting through a distance. While we ordinarily say and assume that work is done whenever effort is put forth, technically and in the sense of the following chapters, there must be motion when work is accomplished. The force acting must act through a distance. If, for example, a horse pulled strenuously on a load without moving it, he might exhaust himself through the effort

* Doubleday, Page and Co., Garden City, N. Y. $1.20 net.

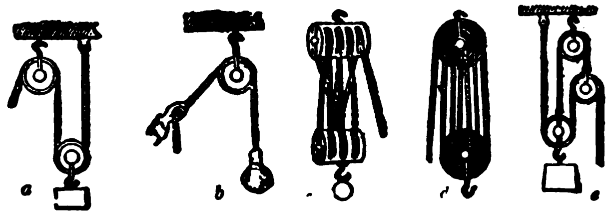


FIG. 237. Pulleys enable us to do heavier work than we otherwise could, but the greater the gain in force the greater the loss in time and distance. Thus in *a*, a 5-pound pull will lift a 10-pound weight, but 10 feet of rope will have to be pulled to lift it 5 feet; in *b* the pull and weight are equal, the pulley being merely a convenience; in *c* a pull of 10 pounds will lift 70; in *d* a pull of 10 pounds will lift 60; in *e* a 4-pound pull will lift 16.

put forth, yet in the technical sense no work whatever would have been done. If the load moves, the work done is the *average pull measured in pounds multiplied by the distance the load moves in feet.* It is expressed as so many "foot pounds" of work.

Power is the rate of doing work. Here the element of time enters in. A 2-horsepower engine will fill any silo if you give it time enough, but a 15-horsepower engine will fill the same silo in much less time. *The amount of work done per second, per minute, or per hour measures the power of any machine.* Here is the reason for the difference in size between the stationary farm engine and the automobile engine capable of exerting the same power. The stationary engine is of slow speed, so that the piston moves through a comparatively short distance in a minute and each explosion represents considerable force requiring large and heavy construction. The automobile engine, on the other hand, is a high-speed machine with less powerful explosions, occurring much more often. Its piston moves through a much greater distance in a minute; hence it may be made small and light. Both engines do the same amount of work in a minute, if operating at the same horsepower, only the smaller engine does a little at a time and does it oftener.

Work, as mentioned above, is measured in *foot pounds.* Multiply the force in pounds by the distance in feet through which it acts and the result is the work done. In raising a weight of 12 pounds 2 feet from the ground, the work done is 24 foot pounds. If the average total pressure of steam on the piston of a steam engine is 500 pounds and the length of the stroke is 2 feet, 1,000 foot pounds of work are done every stroke. If there are 150 strokes per minute, the work done per minute by the steam on the piston would be 150,000 foot pounds.

Power is measured by the amount of work done per minute, the unit being 33,000 foot pounds per minute or 1 *horsepower.* This number 33,000 is merely an accepted standard and does not represent the power of an average horse, although at one time it was thought to do so. In the engine spoken of above, the work done per minute by the steam on the piston is 150,000 foot pounds. As 33,000 foot pounds per minute represent 1 horsepower, this engine has an input of a little more than $4\frac{1}{2}$ horsepower (150,000 divided by 33,000 equals $4\frac{53}{100}$).

Some of the input (total power) of every machine is used in running the machine itself, largely in overcoming friction and in moving heavy parts. For example, in the engine above probably 1 horsepower is required out of the $4\frac{1}{2}$ to operate the engine. The remaining $3\frac{1}{2}$ horsepower would be available for operating a sawmill, a silage cutter, a pump or any

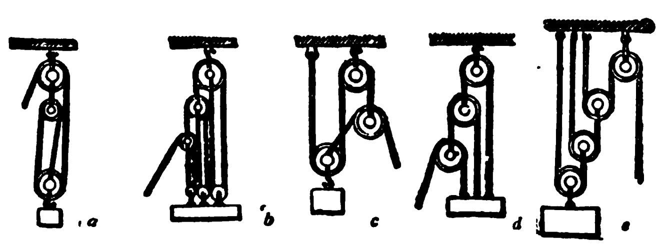


FIG. 238. Types of pulley combinations. In *a*, a pull can lift three times itself; in *b*, six times itself; in *c*, five times itself; in *d*, seven times itself; and in *e*, eight times itself.

other piece of machinery around the farm. Thus the engine is not 100 per cent efficient. The engine gives the value of only $3\frac{1}{2}$ horsepower output for every $4\frac{1}{2}$ horsepower input and has an efficiency of nearly 78 per cent, which is found by dividing the output by the input ($3\frac{1}{2}$ divided by $4\frac{1}{2}$ equals .78 multiplied by 100 equals 78 per cent).

**Efficiency of machines.** No machine known has 100 per cent efficiency. Every machine has to have more power put into it than it delivers, whether water wheel, electric generator, steam engine, potato digger, pump, or other apparatus. Some machines are more efficient than others, usually because of better design and better workmanship, not because of any difference in the process which goes on within the machine. Some processes are extremely inefficient, and so we think of the machine itself as being inefficient. An instance is the steam engine. Without doubt 80 to 90 per cent of the power exerted on the piston by the steam is delivered to the driving pulley; that is, a well-made, carefully designed steam engine has an efficiency equal to that of most well-constructed machinery. As a means of getting mechanical power out of steam, however, it is inefficient, for the process which goes on inside the engine is astonishingly wasteful. The steam contains a certain amount of energy when it enters the engine, but it still contains much of that same energy when it is finally exhausted. The engine is able to use but a small part of the steam's energy, but what it does take is usually delivered with but little loss to its driving shaft.

However, the efficiency of any machine is not necessarily the most important factor in its *value* or importance. Many machines could be made more efficient by refining them; but the refinements would cost so much that the added value of the output would be much less than the interest charge against the investment. The real desirability of any machine must take into account both its cost and its efficiency, and a nice balance between the two must be preserved. In most cases dealing with farm machinery and power, the first cost as well as the operating expense is a deciding factor. Increased efficiency at extremely high cost is desirable only in rare instances.

## Simple Machines for Increasing the Power of Men and Animals

The work that a man can do armed only with a simple machine, such as a crowbar, a winch, a block and tackle, or a lifting jack, is surprising to people not familiar with these tools. It is quite true that a man's strength cannot be increased by these machines nor by any form of machinery. He can do only just so much work anyway; but various devices, including levers, pulleys, inclined planes, etc., enable him to exert his force in such a way that it is multiplied. Tests have shown that a well-developed man can deliver about one eighth horse-

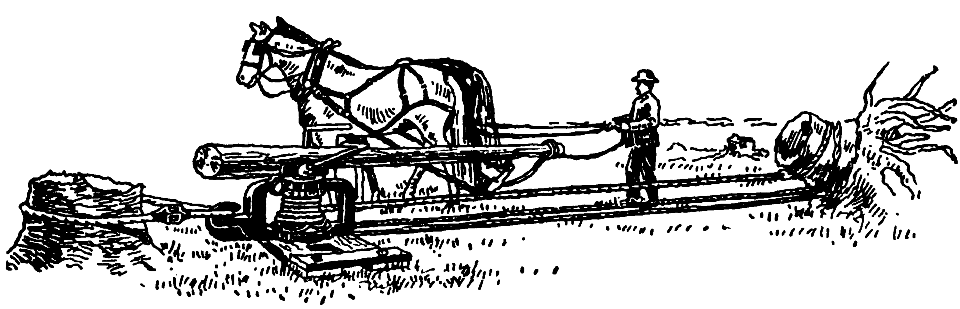
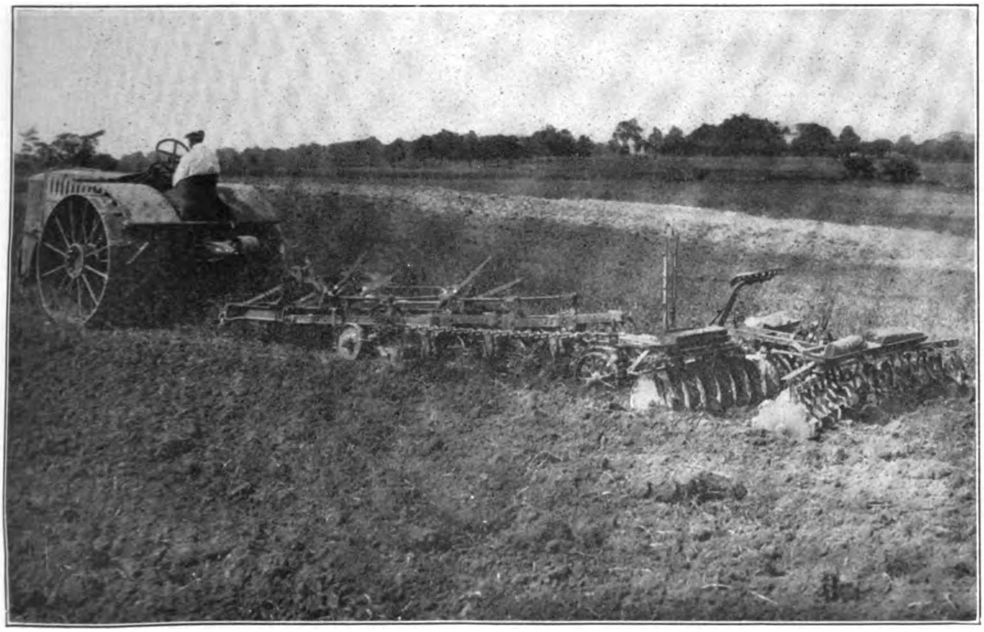


FIG. 239. A stump puller worked on the horse-sweep principle illustrates the use of both the lever and the pulley or windlass

Under stress of war conditions, farming sometimes returns to prehistoric conditions and methods. This is an actual farm scene as photographed in France in 1917



The upper picture shows what sometimes has to be done; this one shows what inventive genius and mechanical skill have developed for use under more favorable conditions

MAN POWER IS NO LONGER THE MOST ABUNDANT AND CHEAPEST FORM FOR FARM USE. IT MUST BE CONSERVED IN EVERY POSSIBLE WAY

Natural power, such as that from wind, water, and the heat of the sun, is the most abundant, but not always the cheapest or most efficient.

**Horse power is reliable, flexible under varying conditions and does not require mechanically trained operators. Its greatest disadvantage is its overhead cost**

**THE FARMER'S POWER SUPPLY IS SAFEGUARDED BY THE FACT THAT IF HIS ENGINES BREAK DOWN HE CAN FALL BACK ON NATURAL SOURCES IN THE EMERGENCY**

power continuously, but that for a minute or two he can put forth something more than half a horsepower.

Suppose, for example, he develops one fifth horsepower, that is, does 6,600 foot pounds of work per minute on a machine, say on a lifting jackscrew. The jackscrew does no more work on its part than he does. However, the man may exert a force of only 66 pounds through a distance of 100 feet in pushing the bar around, while the jackscrew may raise the weight on it only 2 feet, in which case it will have lifted with a force of 3,300 pounds—far more than the man could have exerted. The object of the jackscrew, the crowbar and other similar helps is, then, to multiply the force that can be exerted on any object; in such a case the distance through which such object can be moved in a given time is always less than if the force could be applied directly.

**The lever.** Suppose a large stone is to be moved. It cannot be lifted directly and a crowbar is necessary. This is put in the position shown in Fig. 240 with the fulcrum placed just as near the load as possible. Why? Because, as a result, less force is required to lift the load. The work done by


FIG. 240. How the lever works

the man at one end of the bar, that is, the force he exerts times the distance through which it is exerted is the same as the weight lifted times the distance through which it is moved, just as in the case of the jackscrew. The nearer the fulcrum is to the load, the longer the sweep moved through by the man and the shorter the distance the load is moved. In the same proportion, however, the load moved is greater than the force exerted.

The inclined plane in many forms is also a machine with which we can perform a task which would be too much for us unaided. Very few of us could roll a barrel of sugar right up the side of a building (from A to B, Fig. 241), but most of us could roll it up a slope (as from C to B) if it were not too steep. In either case the same amount of work is required; but in the first case a large force must be exerted through a short distance (A B), while in the second the distance

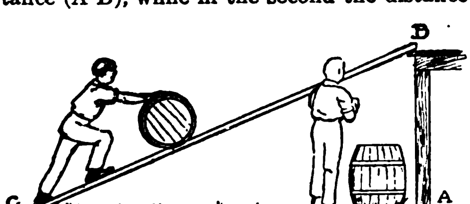



FIG. 241. The inclined plane and what it does. (See text)

is greater, but the force required is correspondingly less. In most cases, distances over which to work are practically unlimited whereas our strength is decidedly limited.

Another way of lifting the barrel would be by means of a lifting jackscrew as already described above. In fact, this machine is merely an adaptation of the inclined plane. To show this, cut out of a sheet of paper a 3-sided figure representing an inclined plane. Wrap this paper around a lead pencil or broom handle (Fig. 242), so that the edge B C lies along the pencil and the edge A C overlaps itself. The edge AB now forms a screw thread around the pencil just like the winding thread on a jackscrew. If you cut the paper so that the distance A to C is just equal to the distance around the broom handle, then BC is just equal to the "pitch" of the thread,

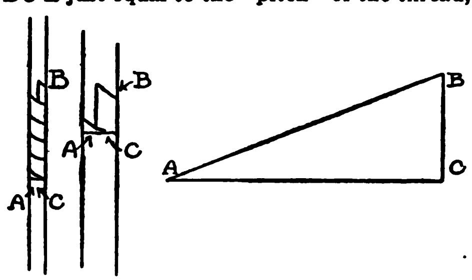



FIG. 242. How the screw works upon the inclined plane principle. (See text)

that is, the distance the screw moves up or down in making 1 revolution. Operating a jackscrew is, therefore, like pushing a load up an incline—the less the slope, the easier the task. In choosing a jackscrew, then, remember that the less the pitch for any given diameter and the greater the diameter for any given pitch, the easier the jackscrew will operate under a load, because the shorter BC is compared with AC, or the longer AC is if BC is unchanged, the less the incline or slope of AB. Further ease is obtained in operating a jackscrew by using a long bar as a handle, since this makes use of the leverage principle, as discussed in the case of the crowbar above.

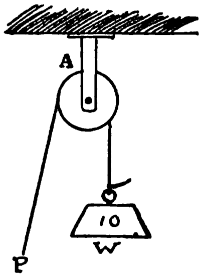


Fig. 243. Simple pulley

**Pulleys.** With a series of pulleys known as a block, a tackle, or sometimes as a block and tackle, similar principles are involved. Almost unlimited multiplication of force is possible by increasing the number of pulleys. A rope passed over a single pulley and pulled on one end will exert a similar pull on the other (Fig. 243). To balance a 10-pound weight (W) a pull or force at P of 10 pounds is needed. It makes no difference whether a pull of 10 pounds is applied at P or a weight of 10 pounds is hung there—in either case the weight (W) is balanced. Then the hook (A) supports 20 pounds with both weights on, and this strain would still be 20 pounds if a 10-pound pull were substituted for the weight (W).

This suggests a way of multiplying force. Suppose a horse can pull 200 pounds. Then if we hitch up our single pulley as shown in Fig. 245, with the supporting hook (A) hitched to a load, the stump S (corresponding to W in Fig. 243) will exert a force of 200 pounds, the horse will exert a pull of 200 pounds and we will be moving 400 pounds. For every foot the load moves, however, the horse must move 2 feet, taking up a foot of rope on each side of the pulley. Again, in exerting a large force through a short distance a lesser force has to be exerted for a greater distance.

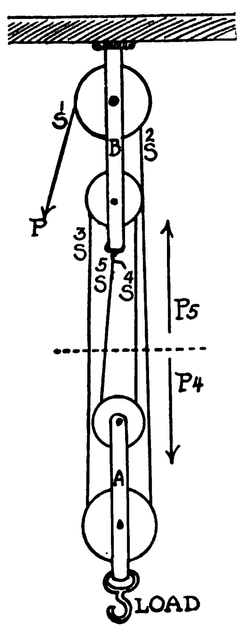


Fig. 244. Compound pulley

A series of pulleys, either separate or, more often, in a single or double block, is used for the same purpose—that of letting a small force, acting through a long distance, move a large force over a correspondingly small distance. In Fig. 244 (in which the pulleys in each block could just as well have been side by side instead of one below the other), a force of P pounds is being exerted on the rope. Then every part of the rope pulls on each block with a force of P pounds, whether P equals 10 or 100. The lower block (A) is pulled on by 4 ropes so the whole pull on it is 4P and this is the load it will hold. If the pull (P) on the rope is 100 pounds, then the pull on the lower block will be 400 pounds. The upper block (B) has 5 ropes (S1, 2, 3, 4, 5) each pulling P pounds on it, or all together pulling 5P pounds. If the upper one is held fast, the lower block will move only 1 foot for each 4 feet the end of the rope is pulled; if the lower block is fastened, the upper one will move only 1 foot for each 5 feet the end of the rope is pulled.

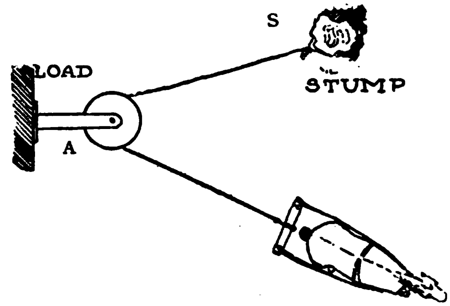


Fig. 245. Pulley applied to land-clearing operations

The author is familiar with a tremendous job of land clearing done very rapidly by means of a rig like this. The block A was anchored to a large stump, the end of the rope hitched to an automobile, and the block B fastened to a whole group of young saplings, which were yanked out of the ground at a very satisfactory rate. Of course, horses could be used in place of an automobile, but less speed would be obtained in clearing.

The wheel and axle, especially in the form of a winch, a capstan, a horse sweep (Fig. 239) or a treadmill, involves the same principle as the lever. A leverage is obtained whereby a small force works through a long distance and in course of time accomplishes a large task. The horse sweep is made for any number of horses, even 12 or 15 being sometimes employed. It is not very efficient, although satisfactory as a cheap method of getting a small amount of power for a considerable period.

A treadmill is more frequently used to get power from animals. It consists of an endless apron carried over 2 cylinders and supported by rollers on a platform, the arrangement resembling a belt over 2 long pulleys. A shaft passes through one cylinder and from this power is taken to the machine operated, either directly or through belts or gears. In such a treadmill the work done is the force exerted by the horse in lifting a portion of his weight up the incline. The power developed depends on the slope of the tread, the speed with which the horse moves, and the friction of the machine (which is lessened as far as

possible by careful and complete lubrication). For best efficiency and continuous action the horse should not travel faster than 2 or 2½ miles per hour. The slope of the treadmill should not be greater than 1 in 4 (1 foot rise for every 4 feet of length) and this is very likely to overwork a horse unless care is taken to keep him at it for only a short time. A slope of 1 in 6, or 1 in 8 will enable an average horse to work a reasonable day without becoming overtired.

At a slope of 1 in 8, a horse lifts one eighth of his weight and transmits this force to the apron at the rate he walks. If he weighs 1,200 pounds and walks 2 miles an hour (176 feet a minute), he does $\frac{1200}{8} \times 176 = 26{,}400$ foot pounds of work per minute and so delivers four fifths horsepower continually. This is about the maximum rate at which a horse of this weight should be worked for any continuous period. Twelve-hundred-pound horses have been known to deliver 3 and 4 horsepower for short periods, while in a very brief, horizontal pull a 1,500 pound horse has been known to exert an effort greater than his own weight. The proportion of the power delivered by the horse available for useful work depends upon the efficiency of the machine; in most cases it should be from 60 to 80 per cent.

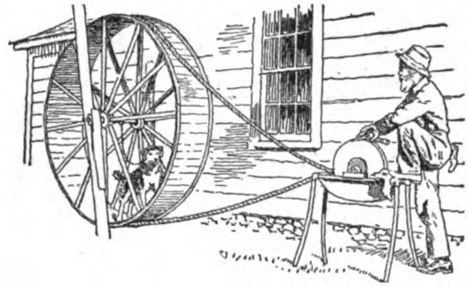


FIG. 246. In this homemade power plant the dog continually ascends an inclined plane; but this, being movable, exerts a lever action around the axis of the wheel the motion of which is conveyed to the grindstone by the rope belt.

## Power Machinery on the Farm

The great change in the condition of life throughout the country during the past century has been due in a large measure to the substitution of power and machinery for hand and animal labor. The growth in population and wealth is due mainly to this cause. Starting with the invention of spinning and weaving machinery, followed successively by the steam engine to furnish power and transportation means and methods to suit the changed conditions, every step has seemed to bring together and bind more closely the various sections of the country, to promote the standard of existence, and to make possible the great democratic movements of the age. No better example could be given of the results of power substitution on existing conditions than the influence of the invention and marketing of the automobile and its effect upon the life of the farming community. Distance is removed, the country is but a part of the town, and all residents of the county are neighbors and ready to join in the many neighborhood and community movements, whether for commercial, industrial, or social betterment.

## Choosing and Purchasing Machinery

Recognizing the value of power machinery, the problems which present themselves are: (1) What are the main functions or purposes of machinery? (2) What machinery will best serve me? and (3) What can I afford to buy? An understanding of the true function of power machinery is a real aid in any proper purchasing decision. All power machinery does 1 of 4 things: (1) it saves time in accomplishing certain results, usually by permitting the application of greater force or by allowing force to be applied in a more efficient manner; (2) it saves effort or force, usually at the expense of time; (3) it saves cost, usually by permitting the use of less expensive sources of force or less expensive materials; or (4) it saves neither time, force, nor cost, but accomplishes the desired result in a neater, better, or more desirable way than that possible with hand labor.

**The real value of power machinery.** We are all too apt to measure the value of new apparatus by immediate returns to us in dollars and cents. Nothing is so

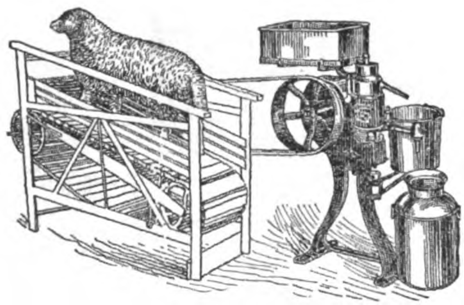


FIG. 247. The treadmill (see also sketches at head of chapter) is a further adaptation of the inclined plane

certain as this to narrow our viewpoint and hinder our progress. A saving of time in accomplishing a certain object may or may not result in a saving of cost, but frequently it will make all the greater the enjoyment of what one has. A saving in force may not result in a direct saving in money; but if it makes things easier to do, it makes possible the doing of more things or the greater enjoyment of life while those things are being done. If the end accomplished is in any way better or more desirable than that which could be attained without power, it is worth while and should not be at once condemned because of its greater cost. Not only is the thing worth doing surely worth doing well, but the care and desire to do the thing well has a much deeper effect than can be measured by mere material standards.

**The real cost of machinery.** In any purchase, several questions must be taken into consideration. In regard to the purchase price: (1) Does the price asked include all necessary attachments or accessories required to get the full benefit of the machine? (2) Is the machine *better* than some cheaper competing machine, or is it merely *different* or fitted with nonessential additions which the cheaper machine lacks? (3) If the machine is guaranteed, just what good is the guarantee; does it mean that defective parts will be replaced free, or that the machine may be returned and the purchase price refunded if the machine is not satisfactory; and is the guarantee for a long enough period so that the machine may be tried out under varying conditions? (4) Will the machine prove worth the purchase price? In answering this last question you must consider the result to be accomplished. Will the machine do the work you wish to accomplish with some kind of saving?—not necessarily some saving in cost, but one either in time, effort, convenience, or cost.

**Cost of machinery operation.** The items of machinery operation are many. There is always the human element—the number of attendants necessary and, sometimes more important yet, the degree of skill or intelligence required of them. Obviously, if 2 laborers may be replaced by 1 man, and that one must be a highly skilled mechanic, hard to get in the first place, and requiring a salary away out of proportion for the work desired, the apparent saving in attendance is not at all real. On the human side, 4 things must be considered: (1) How many men are required? (2) What degree of skill or intelligence is required? (3) How easy is it to secure men of the required standard in the locality and at the times when the work is to be done? (4) To what extent will any other help or operations be affected?

Outside of the human element, there are 3 things to be taken into account: (1) the material required for the machines; (2) the auxiliary machinery necessary; (3) the deterioration or depreciation in the machine as affected by its method of operation, foolproofness, complicated nature, and materials of construction. The materials required for operation will come under the heads of: (a) lubricants, (b) substance operated on, (c) waste, (d) fuel, and (e) upkeep material, such as paint or other coating, wrapping, packing, or repairing. For example, a water pump will possibly require under (a) both oil and grease. Under (b) it must be considered whether the pump is for sea water or fresh water, whether the water is clean or sandy or full of suspended matter, and whether it is acid or injurious in any way in its effect on metals. Under (c) there would be no consideration; while (d) would bring out the method of operation, whether by direct steam

action, by belted drive from some other source, or by direct connection to an outside motor or engine. Under (e) would be considered paint for the exterior, packings and washers for stuffing boxes and valves, possible protection against unusual temperature changes, possible duplicate parts such as bolts, washers, nuts, valves, fittings, oil and grease cups, etc.

The auxiliary machinery necessary would be for 1 of 3 purposes: (1) to drive or supply power to the machine in question; (2) to be operated by the machine in question; or (3) to supply some operating need of such machine. For example, the auxiliary machinery required for a mowing machine is (1) some driving power, such as a horse or tractor, and (2) a grindstone or emery wheel to supply an operating need, viz., the sharpening of the knives. This, in turn, requires a method of driving, a means of lubrication, and, usually, a water supply to the stone.

**Depreciation of machinery.** The depreciation of the machine should not be considered along with its repair. Depreciation is brought about by more than mere wearing out. An automobile, for example, after running its first thousand miles or so should be a much better machine, run more smoothly, have greater speed and flexibility, be more easily handled and better adjusted than when new, and yet its depreciation is a very heavy percentage. Probably no other thousand miles causes greater depreciation, yet no other thousand miles does the car more good, if properly handled. Depreciation really means change in selling value under conditions of forced sale. All farsighted men allow each year for the depreciation of their belongings and outfits and, in one way or another, make arrangements so that, when required, the machinery may be completely marked off the books. Changes in styles or fashions, possible changes in law or in standards of living, new inventions which render the old machine obsolete—the knowledge of the possibility of any or all of these things causes every prudent man to charge up against operating expenses every year a more or less definite fixed percentage of the value of the machine, which is called "depreciation." This amount should be such that, if continued right along through the probable useful life of the machine, the whole sum charged up, together with accrued interest, would be sufficient to replace the machine.

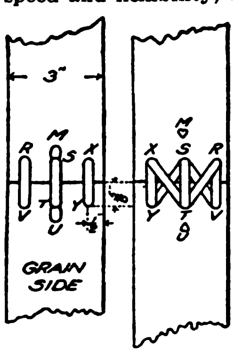



Fig. 248. Lacing a three-inch belt. With grain side down, put one end of lace down through S and up through M; then lace other end as follows, passing downwards through the first hole, up through the second, down through the third, etc.: V, R, V, R, T, S, Y, X, Y, X, T, S, U.

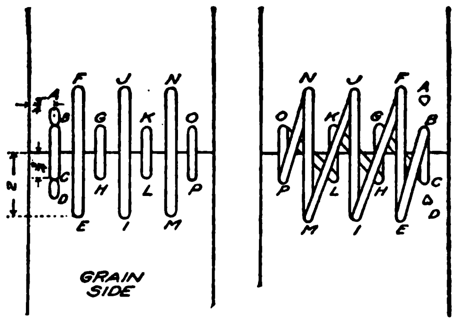



Fig. 249. Lacing a six-inch belt. Fasten one end of lace down through C and up through D. Run the other (long) end alternately down and up through holes B, C, G, H, K, L, O, P, O, P, N, M, J, I, J, I, F, E, F, E, B, C, B, and A. The grain side runs on the pulleys. (This and Fig. 248, from Farmers' Bulletin 638)

In most cases, the depreciation when a machine is new is much greater than for the same machine when 3 or 4 years old. Also, the percentage depreciation on a second-hand machine is not so heavy as on a new machine, not because of the less cost, but because of that peculiar psychology in men which causes them to consider a machine purchased from the original buyer much more desirable than when purchased from the second owner, yet there is no choice whatever between the second, third, and fourth owners. A second-hand machine is second-hand, whether it has changed hands once or a dozen times. This is particularly true of farm machinery as a general rule.

**Repairs.** Repair of the machine, altogether apart from its depreciation, is a yearly item of expense. The more complicated the machine, the greater the repair bills and the more likely that delay will occur because of the need for getting a skilled workman to make the repair. The more nearly foolproof the machine is, the less the repair bill, no matter how skilled and intelligent the operator may be. Repairs are affected in various ways, for example, by the nature of operation, whether inspection can be made while operation is going on, whether quick shutdowns can be made in emergencies, and whether the load must be thrown on with a jerk or may be gradually applied without jar. Last but not least, the materials of construction affect the repair bills. Particularly is this true of any wearing part, such as a friction or rubbing surface, of any part exposed to undue heat, and of any part exposed to undue strain or shock. Such parts should be specially designed for their purpose, and the materials specially chosen to meet the condition existing.

## Classification of Power Machinery

Most of the machinery used on the farm is power machinery, particularly as the tractor invades more and more the province of horse and cattle. Yet all farm machinery may be classified under, perhaps, 4 heads: (1) machinery affecting land for crops; (2) machinery affecting the care of stock; (3) machinery affecting the preparation of farm products for market or home consumption; and (4) machines affecting general living conditions on the farm. In Class 1 would be placed the tractor, plow, harrow, ditch digger, etc.; in Class 2, litter carriers, milking machines, pumping apparatus, sterilizing machines, etc.; in Class 3, wood saws, harvesting machines, corn shellers, cold-storage machines, etc.; and in Class 4, running-water apparatus, electric lights, heating apparatus, vacuum cleaners, dish washers, laundry apparatus, automobiles, etc. Most of these having been discussed in other chapters, it will only be necessary here to treat of two or three, such as the power ditch digger and the various pumps.

The distinguishing feature of the modern farm is the inclusion in its machinery of some of the items of Class 4. The other apparatus is largely money-making. The machinery of Class 4 does more than make money: it makes life, helps to remove drudgery, and brings an amount of joy and happiness into the life of the farm housewife that is more than desirable—it is a necessity, a right which she may properly claim as a copartner in the operation of the farm as a business unit.

### Machinery for Crops

One of the most important recent developments in farming is the growing adoption of the farm tractor on the smaller-sized farms. The tractor having been treated in Chapter 6 of Part I of this volume, only a few features will be mentioned here. Some of the advantages in particular may well be recapitulated. They include the low cost of maintenance when not in use; possible 24-hour use when desired; flexibility in operation in the field or for road hauling and as a stationary power plant about the farm, movable by its own power; low cost of operation per unit of work and, lastly, elimination, to some extent, of the labor demand at various seasons of the year.

Agricultural machinery is taken up in detail in Part II, and the function of this article is merely to call attention to the different types of the same machine for different purposes. The small farmer must not, and cannot economically, have plows and harrows each specifically designed for special service in some part of his field. On the other hand, the big farmer, to achieve success, must have this sort of equipment. Each must consider all types; and, where 1 or 2 are sufficient, the right compromise must be studied out from an intimate investigation of all.

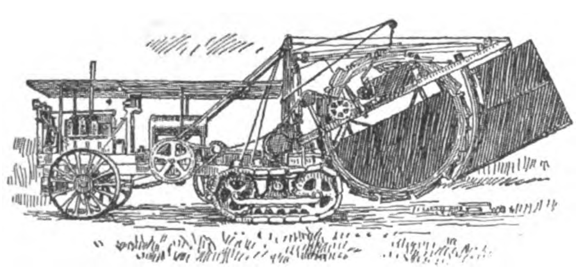


Fig. 250. Gasoline-driven, caterpillar-tread ditching machine, showing digging buckets around wheel at right, also apron and travelers for removing earth to side of ditch.

**Power ditching machine.** A machine not in wide use, but which is extremely desirable where extensive ditching is done, is the power ditch digger. There are several types, all different in details, and, of course, in quality of workmanship. There are 2 functions which these machines have: (1) excavation to required dimensions, width, and depth; and (2) the delivery of the excavated material to some point on one side or the other or on both sides of the trench. A necessary feature of operation is the ability of the machine to propel itself forward as the ditch is dug. So far as the writer knows, in no type of digging machine is any provision made for filling in the trench. Where this is desired, it is done with horse shovels, scrapers, and by hand shoveling. On the farm, the ditches are more often left open for drainage and irrigation purposes.

The excavating mechanism is frequently a bladed wheel about 10 feet in diameter, chain-driven, and pivoted on the end of an arm which moves up and down, hinged on the main body of the machine. This up-and-down adjustment permits the regulation of the depth of the trench and, also, a gradual start of operations from the ground surface, the wheel being fed slowly

into the ground to the proper depth, and feed of the wheel being regulated by the propulsion of the whole machine forward. An engine, mounted on the body of the machine, is connected to a gear which is in mesh with a jackshaft on which a clutch is mounted. This clutch is so arranged that the engine may be connected through a chain drive to the rear wheels to furnish power for propelling, or to the digging-wheel, through a chain drive, for excavation, or connected to operate both wheel and propulsion at the same time.

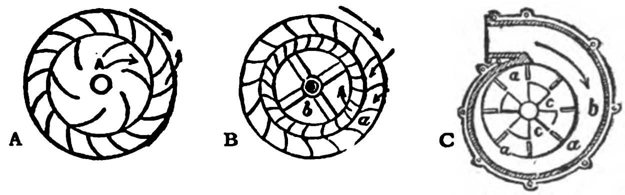



FIG. 252. Three turbine water wheels. In A the water enters at the centre, and is directed by the guides against the buckets of the outer wheel which it forces around before escaping at the edge; in B it enters from the edge and revolves the wheel inside, escaping at the centre; in C the casing is shaped to make the water act against the buckets all the way around, with a final thrust on the interior buckets (*c*) through which it escapes.

The digging blades or shovels around the circumference of the wheel are bucket-shaped and so located as to retain the excavated material until, in the turning of the wheel, the buckets at the top are upside down and the material is dumped on to a canvas belt conveyor which passes through the centre of the wheel. This belt conveyor is arranged to dump the material on either side of the wheel, as desired. If the material is wanted on both sides, as would be apt to be the case in a deep or wide trench, 2 belts, turning in opposite directions, are used. The speed of the machine is from a half mile to 2 miles of trench per day, the trench being 4 or 5 feet deep and 2 or 3 feet wide in one cut.

## Machinery Affecting the Care of Stock

**PUMPS.** Power pumps are properly placed in Class 2, as affecting the care of stock, although, to some extent, overlapping class 4, if they are used for house water supply and, perhaps, Class 1, when they are used for irrigation purposes. They are of 3 distinct types: piston, or plunger, pumps; centrifugal, or turbine, pumps; and rotary pumps. The differences between them are in cost, speed, efficiency, and space required. Both piston and turbine pumps will force water to any height met with in practice. Rotary pumps are not good for really high heads. While piston pumps will operate at nearly the same efficiency regardless of variation in speed, turbine pumps must operate at high speed and any variation causes a large change in efficiency. Constant or nearly constant speed is desirable.

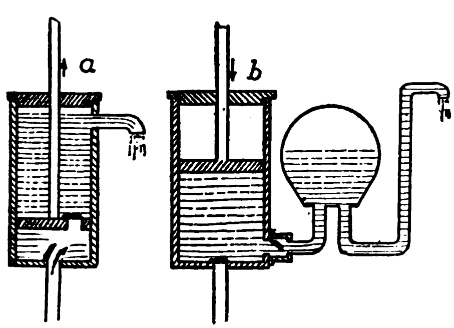



FIG. 251. Diagram to show working of single lift pump (*a*), and force pump with air dome to give a steady flow of water (*b*).

Plunger pumps. These are of the same type as the usual hand pumps. A piston moves back and forth in a cylinder, on one stroke drawing in the water through a check valve and on the next stroke forcing it out through a similar check valve operating the other way. These check valves operate in 1 direction only, so that the intake valve opens only on the suction stroke and the delivery valve opens only on the delivery stroke. In a double-acting pump, both sides of the piston are in operation, the stroke on one side drawing in the water through one set of valves, and the stroke on the other side of the piston forcing out the water through another set of valves.

The speed of such pumps is usually low, say from 40 to 60 revolutions per minute on large pumps, and somewhat more on small sizes. The action is positive, the water being forced out against any pressure that the pump is built to withstand.

This type of pump is most efficient, as it can be driven by any kind of engine; but it is being very widely displaced by centrifugal and rotary pumps because of the comparatively low cost of the latter.

In some kinds of plunger pumps, used for city waterworks and boiler-feed purposes, the water plunger and a steam piston are connected together on a single piston rod, and the steam acts directly through the pistons on the water. This is a sort of combination engine and pump; but the steam is not allowed to expand at all, only the initial pressure being used. This results, of course, in a great waste of steam. On this type there is no flywheel, and the speed can be regulated very nicely by means of the steam throttle.

Another type of direct pump, with flywheel, has a steam cylinder arranged like a steam-engine cylinder, expansion of the steam being permitted. This is widely used for elevators, boats, and condenser purposes.

The ordinary farm pump is operated by belting or gearing from some form of separate

power machine such as an electric motor, gasoline engine, steam engine, or water wheel.

**Rotary pumps.** Pumps of this type give about the same efficiency as centrifugal pumps under the same operating conditions. They may be operated at low speed, are fairly positive in their action, are of low cost as compared with piston pumps, and take up very much less floor space. They are objectionable at high speed because of the noise they make. As compared with centrifugal pumps, they need not be regulated so closely in speed, a variation of 100 per cent not making much difference in efficiency. They take up more room than a centrifugal, and cannot be driven over 700 to 900 revolutions, even in small sizes.

A flat, circular casing contains 2 intermeshing impellers, each shaped like the figure 8. Each is on a separate shaft, and the two turn in opposite directions, being geared together, and the power being applied to one shaft only. The water is drawn in at one side of the casing and propelled out of the other. A variation in speed changes the amount of water delivered in about the same proportion. Rotary pumps are used in small sizes for light duty, where a cheap, dependable, variable speed, but positive-acting pump is desired. They are used only for force-pumping against a short head or low pressure, although, as ordinarily constructed, adaptable to heads up to, perhaps, 50 feet or so.

**Centrifugal pumps.** Centrifugal and turbine pumps are very much alike, the latter being a refinement of the centrifugal as regards the elimination of cross currents in the water within the casing. There are 2 essentials in each: (1) a casing of somewhat similar shape to the rotary casing, and (2) a single impeller of such a shape as to draw the water through the centrally located intake and force it to the circumference of the casing and out of the discharge opening.

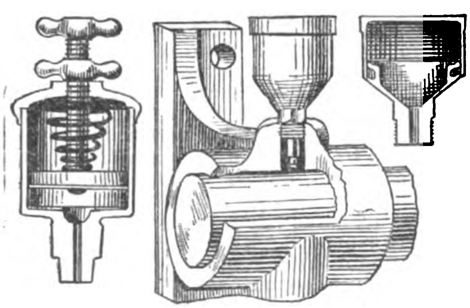


FIG. 253. Spring-equipped grease cup (*left*); ordinary grease cup in section and on a bearing (*right*)

In the centrifugal pump the casing is spiral, like a snail's shell, with the suction inlet at the centre and the full-sized discharge opening at the edge of the main part of the casing. There is only 1 impeller, on a single shaft turning at a high speed. The action on the water is similar to that of a wagon wheel running in a rain-filled rut and throwing mud and water off the tire with considerable force.

In the pump the force is directed; and a single pump, properly designed, is capable of raising water to a height of several hundred feet with an efficiency of over 80 per cent. By arranging several impellers side by side in separate casings, 1 impeller is made to deliver water to that next to it, and a greater range of usefulness is developed. Two, 3, and 4 such impellers are frequent, the pumps being called 2-, 3-, or 4-stage pumps, as the case may be. A stock type of 3-stage pump will deliver 200 gallons per minute against a head of 750 feet running at 2,500 revolutions per minute. Usually, however, the pumps are designed for a lift of about 125 feet to each stage.

Centrifugal pumps in their widest field are found raising huge quantities of water short heights. For irrigation and drainage purposes, they are especially valuable, single units raising up to 100,000 gallons per minute for a lift of from 4 to 10 feet. They may be obtained in small sizes for ordinary farm use and, where they can be driven at high and reasonably constant speed, they are most satisfactory and by far the cheapest, lightest, and smallest pumps that can be obtained. They are nearly automatic in action, having no valves and but few parts; their depreciation and wear are thus reduced to a minimum. The cost of centrifugal pumps runs from 12 to 15 cents a pound for the weight of the pump.

**Air compressors.** In many cases, the use of compressed air is very advantageous. In underground pneumatic tank systems, air compressors are almost essential. A small compressor for tire filling or for blowing purposes, where a blower or fan cannot be used and the jet of air is substituted, is frequently very handy. These compressors are usually low-speed, they operate like a single-cylinder piston pump, and are dependable. There is usually an unloading valve, to throw off the load automatically when the air pressure reaches any predetermined point. Unlike pumps, air compressors must have a water-cooling jacket, like that on the gasoline engine, because the action of compressing air creates considerable heat. Small compressors cost from $30 to $100.

## Care of Power Machinery

In all types of pumps, as in other apparatus, proper and sufficient lubrication must be provided. Lubrication is the one thing which means a long life to any ma-

chine. Without it, most machines will be ruined in a very few minutes of operation under load. It is particularly true that the importance of lubrication be impressed on the farmer operating power machinery, because, while ordinary farm machinery should be well lubricated at all times, it is not usually built so carefully and accurately that lack of lubrication will cause immediate disaster. With power machinery, however, the careful fitting and adjustment of parts, the tremendous forces called into play, the very high speeds usually called for, and the special materials used, all require special care; and the first step in proper attention is lubrication.

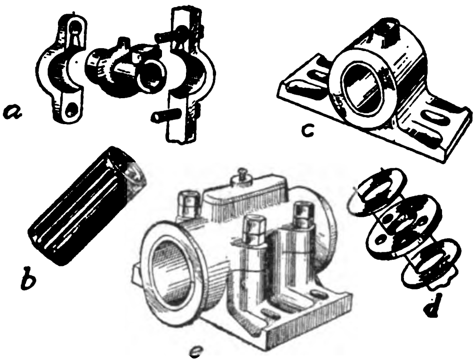



FIG. 254. The bearings are the centre of machine efficiency: *a* self-aligning bearing; *b* roller bearing; *c* plain bearing; *d* ball bearing (the balls fitting in the small openings in the centre plate); *e* split bearing (Ore. Bulletin, 133).

Next to lubrication, care must be exercised by the operator to keep all nuts and bolts tight. Large strains develop, and vibration occurs which rapidly loosens all parts. Periodical inspection during operation and a thorough tightening after every shutdown is desirable.

**Bearings.** The features of all power-operated machinery which should be carefully looked into at purchase and carefully cared for afterwards are the bearings—the portions of the machine which hold the moving parts in place. They are all of plain, babbitt or similar metal, roller, or ball type. The plain bearings are usually carefully drilled holes in proper metal or hardwood, the moving part, which is usually a rotating shaft, being held in place by the material. Such bearings must be well lubricated. The babbitt bearing is a plain type lined with soft metal, so that the friction created is very slight. These bearings, also, require lubrication. In both of these types, the friction of the shaft turning in the bearings is a rubbing or sliding friction.

Roller and ball bearings substitute rolling friction for the rubbing friction of the other types. This requires very much less effort to overcome it and eliminates a large part of the friction in any machine. These bearings are necessarily very well protected from dirt and dust, being packed in grease, which not only protects, but lubricates. The main objection to ball and roller bearings is their high cost. Ball bearings are especially adapted for end thrust conditions, whereas roller bearings are used particularly for radial loads as on axles and horizontal shafts. The diameter of the balls used varies from a very small size up to 1 inch on very heavy bearings. The rollers used most generally run from three eighths of an inch up to a half inch in diameter. The radial bearing in length should be from 3 to 4 times the shaft diameter.

The difficult feature about all bearing settings is to get perfect alignment. To aid in overcoming this difficulty, a type of bearing called "self-aligning" is made, the main bearing box being pivoted in the frame so as to be slightly movable.

**Machine materials.** A complete study of, or even a complete glance at, the multitudinous materials used in machine construction would fill many volumes. Steel and iron, with alloy metals, form the most important group. Steel in particular has received a great deal of study. By combining very small amounts of various rarer metals, such as nickel, tungsten, and titanium, with steel, we get a tremendous increase in the testing strength of the steel and considerable

change in other characteristics. While ordinary steel shows a strength of, say, 60,000 pounds per square inch, alloy steels show up to 200,000 pounds per square inch and sometimes more. This permits lighter and cheaper construction.

Steel differs from iron only in its purity and smaller percentage of carbon. Cast iron is pig iron cast in sand molds. It cannot be forged or welded. It is used for loads in compression. When a particularly hard, difficult surface is wanted, part of the mold is made of iron in place of sand and the cast iron runs against it, becomes chilled, and the surface gets very, very hard.

Cast steel is cast iron with some carbon removed. It is more dependable and stands shock better than cast iron. Gears are frequently made from it.

Wrought iron is almost the pure metal. It is easily welded and worked. Steel is, of course, easily worked, but is hard to weld except by the electric-welding process.

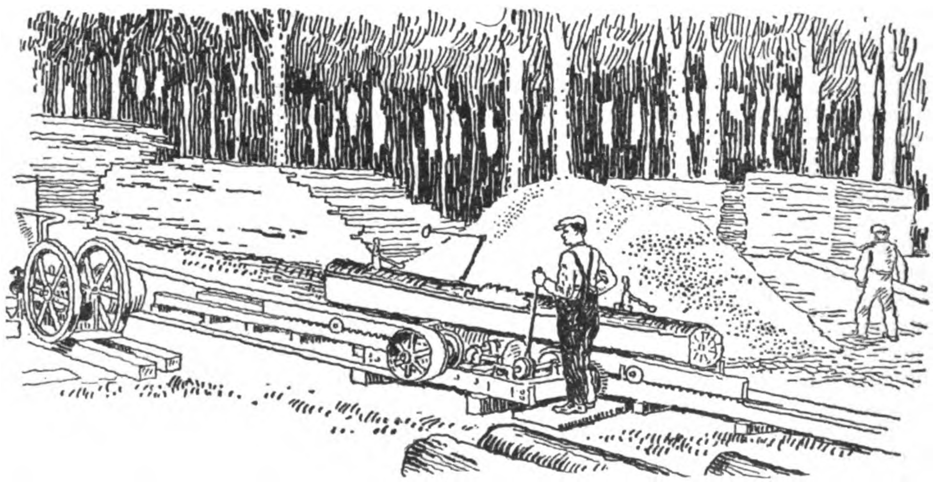


FIG. 255. A portable wood-sawing outfit run by a stationary gasoline engine. With such a machine the farmer can get out his own lumber and often do a good deal of profitable work for his neighbors

# CHAPTER 15

# Windmills

*By* PROFESSOR R. P. CLARKSON *(see Chapter 14.) The windmill is so familiar an object on the farm that its importance, value, and needs as a piece of machinery are apt to be overlooked until a breakdown occurs. At this point the farmer may blame the weather, the mill itself, the makers, etc.; or he may have an awakening and see himself and his neglect as the real causes of the trouble. With knowledge of just what kind of a machine it is, what it does and how to care for it, he might have prevented the trouble in the first place and also assured himself of longer service from the mill. This chapter provides such knowledge.*—EDITOR.

THE source of power to which the farmer has naturally turned in the past, and to which he still rightly clings, is the wind. For ages wind power has been employed to drive the vessels of the sea, and for almost, if not fully, as long the windmill has been used for grinding grain. During the last decade or two, serious thought has been given by scientists and engineers to the project of using the force of the wind indirectly through the novel form of wave motors. Wind and falling water together with the tides and the heat of the sun are the four so-called "natural" sources of power to which, in ever-increasing degree, the minds of the power engineers are turning. Undoubtedly, the windmill, even in its most highly developed form, is the least efficient of all our power apparatus, while the hydraulic turbine is by all means the most efficient of our prime movers. Almost all inventions and changes in design and construction of our prime movers have but one aim—the increasing of efficiency. The increased utilization of water power and the study which that involves are responsible for the great advances shown in the modern turbine over the old grist mill wheel. The same amount of study has not, of course, been devoted to the windmill, and as a result the improvement over the old-fashioned Dutch mill is not great.

**Advantages.** The value of any source of power to the farmer is in direct ratio to (1) reliability; (2) cheapness of installation; (3) cheapness and ease of upkeep; (4) durability; and (5) simplicity. In all these features, the windmill stands well. It is reliable in its action, and its general average of operation in any locality is a thing easily ascertained. It is cheap to install, its cost depending on what is desired. It requires but little care, and the upkeep cost is extremely low. Its life is long, if reasonable attention is paid to rust prevention. It is easily understood, and no part of the machinery is at all complicated or easily put out of order.

A disadvantage in utilizing the breezes, as in all natural sources, lies in the continual variation in their intensity and direction, as well as in their complete cessation at times. The changes in direction may be momentary, if induced by surrounding local conditions; or they may be very decided, if due to the shifting of pressure centres and the resulting change in the point of the compass from which the wind blows. Modern mills are arranged to turn with the more decided shifts in direction, thus presenting at all times a proper surface to the wind action. So far as possible, an effort is made to avoid local effects by raising the fan portion of the windmill to a considerable height, and by placing the structure in a clear, open position.

The following table gives as closely as possible the velocity and pressure of the wind for ordinary breezes.

WIND TABLE

| KIND OF WIND | VELOCITY MILES PER HOUR | VELOCITY FEET PER SECOND | PRESSURE EXERTED LBS. PER SQ. FT. |
|---|---|---|---|
| Light breeze . | 3 to 4 | 4.4 to 5.86 | .03 to .05 |
| Gentle breeze . | 6 to 8 | 8.8 to 11.7 | .11 to .19 |
| Brisk wind. . | 15 | 22 | .68 |
| High wind . . | 30 to 35 | 44 to 51.3 | 2.7 to 3.66 |
| Gale. . . . | 45 | 66 | 6.1 |
| Hurricane . . | 80 | 117.4 | 19.2 |

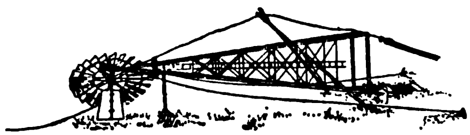


FIG. 256. Steel mills of moderate size can be built on the ground, then hoisted into place, fastened down, and hitched up to the pump.

**Wind velocities.** The engineer is, of course, chiefly concerned with the force of the wind, and with the pressure which will be exerted by it against any wheel or other structure placed in its path. A hasty examination of the few figures given above shows that the pressure exerted increases very, very rapidly as the velocity of the wind increases. With the velocity increased 20 times, from 4 miles to 80 miles per hour, the pressure increases 384 times, from .05 pounds to 19.2 pounds per square foot. The effect of this enormous increase in pressure is seen directly in the output of any mill. With a mill having a capacity of 8 to 10 bushels of grist per hour under ordinary brisk wind conditions, the possible output would be doubled if a high wind prevailed.

**Old-type mill.** The old type of Dutch tower mill is still seen, with its foundation of stone surmounted by a frame tower having latticed sweeps or blades over which sails can be drawn. The tower is movable by a "veering mechanism," to bring the blades into direct relation with the breeze. Some of these mills are of several stories and are often 100 feet high or more. The blades are frequently 25 to 30 feet from shaft to tip of blade; and they are so geared to the grinding stone that the stones make from 10 to 12 revolutions to each turn of the sails.

**The modern windmill.** The modern windmill is built for a much wider range of work. Its chief field is, apparently, pumping; but it has many other uses, including in some localities that of operation of the farm electrical plant. It differs from the old windmill in being made of steel, with a light turbine-shaped wheel, usually 10 to 12 feet in diameter, and never in the largest mills over 40 feet in diameter. The steel towers are from 40 to 100 feet in height. A ladder provides access to the mill wheel for repairs.

**The wheel.** The wheel itself is a very important part of the machinery, although in the old mills, a large proportion of the power was doubtless lost in transmission through the gears and shafts from the wheel to the millstones. The most modern wheels have a steel framework with radially placed sails of sheet metal, shaped somewhat like the blades of a screw propeller. They resemble, also, the blades of some forms of fans. The exact form of curvature adopted is not mathematically determined, even as much as the shape of water turbine wheels; but, like them, it is an outgrowth of experiment and test. Obviously, with the varying velocities of wind, there must be a compromise in the shape of sails, to give good results with each velocity. There must be a best shape for any one velocity; but, where a compromise is made, it can readily be seen that there is room for considerable difference of opinion, and indeed the manufacturers differ quite decidedly among themselves. Experiments have shown, however, that a twisted sail has but slight advantage over a surface which has a flat constant angle presented to the wind. To put it crudely, the fancy and complicated shapes occasionally marketed are not so desirable as the simple plain forms of sails resembling the old flat Dutch sails, except that the present form is curved radially from shaft to outer ring.

With even the best wheels, a large proportion of the air passes through between the sails and, of that which does strike the sails, only a portion of the energy is absorbed. The result is an over-all efficiency of windmills of only 8 to 15 per cent.

Veering devices. Various

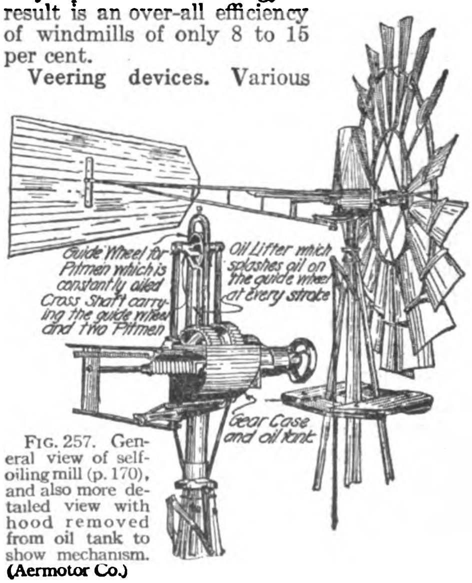



FIG. 257. General view of self-oiling mill (p. 170), and also more detailed view with hood removed from oil tank to show mechanism. (Aermotor Co.)

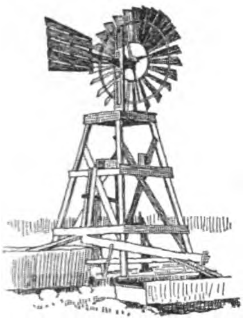


FIG. 258. Small, farm-made mill in which fan, wheel, and tower are all of wood.

veering devices have been employed in the various types of wheels, to keep the sails headed up into the breeze. At present, the tail vane stuck out behind from an extended arm is almost universally adopted. The best mills are mounted on roller bearings and easily moved, so that the size of the tail vane must be carefully determined by experience. If too small, the mill does not respond quickly to slight variations in direction; if too large, the mill is continually moving or oscillating in a stiff breeze. The vanes, like the sails, are made of sheet metal.

**Transmission gear.** The transmission gear in modern mills is the device for changing the rotary motion of the wheel to a reciprocating motion suitable to operate the pump plungers. The change must be made from the horizontal rotating shaft of the wheel in the air to the vertical plungers extending down to the ground. This gear is the main point of difference between the various windmills; and in most trials, such as used to be held at the various fairs, this gear has been the main reason for the superiority of certain makes of wheels over other makes, the difference in the mills being much greater than those made possible merely by the slight differences in sail design.

Although in all forms of engines the force end has a reciprocating piston stroke, which is changed to a rotary shaft motion by means of a crank and connecting rod, this same device is not used in any of the larger types of windmills to reverse the operation and change rotary into reciprocating motion. It is used, however, in many, or possibly all, of the smaller and cheaper mills, the alternate form of construction being a flat pinion arranged to mesh alternately with 2 parallel racks, one of which thus provides a downstroke and the other an upstroke to the pump plunger.

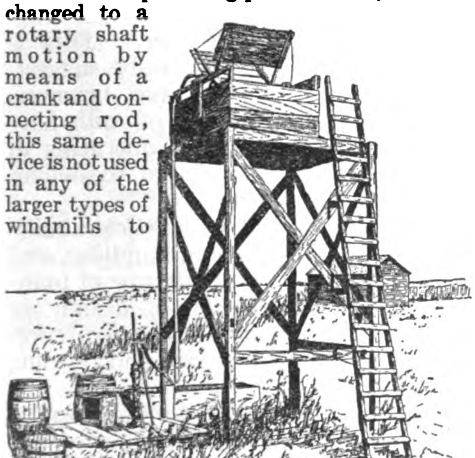


FIG. 259. A small jumbo mill in Nebraska supplying a small hotel and stable, and which cost $3.70 (Cornell Countyman IV-4.)

**Automatic regulating device.** Most wheels in this country have some sort of automatic regulating device, to prevent the wheel from gaining too high a rate of speed. The device, of whatever form, is arranged to change the sail adjustment, and, frequently, it also throws the wheels out of gear with the pump. This is done because of the fact that the pumps used will not work properly at a high speed. The mill itself should stand a gale of wind and operate satisfactorily. In many of the better types, a device is provided which, if anything breaks, automatically throws the mill out of the wind direction.

FIG. 260. The water tank may be supported on the mill tower, on a separate tower of its own, in the attic of the dwelling or the loft of the barn.

**The storage of water.** With any type of pumping apparatus so intermittent in its action as the windmill and so variable in its output, a form of storage must be used. An elevated tank or reservoir is most common. Occasionally, the site is so arranged that a small reservoir may be built on a hillside, usually a masonry or concrete structure partly dug into the hill and partly walled above ground level. More frequently, an elevated tank is built on the same tower with the windmill, or, possibly, in the attic or in the barn loft. In all these cases, gravity pressure is relied on to give a flow of water.

In some installations, the water is pumped into a pneumatic tank, buried underground below the frost-line or placed in the cellar. By creating an air pressure from the compressed air in one end of the tank, a flow of water is established. This air pressure may be pumped in by means of an air compressor, or the water itself may be depended upon to create sufficient pressure by sealing in the air already in the tank. In very few cases is this type of installation desirable, unless the pumping is done by some type of engine.

**Tanks.** Both wooden and metal tanks are used, of all sizes from 150 to 150,000 gallons. Usually about a 4- or 5-day supply is arranged for. For wooden tanks, pine and cedar are regarded as desirable in the East,

while cypress is most favorably regarded in the South and Southwest. Metal tanks are occasionally of cast iron, but more often of sheet metal, either iron or steel. They cost nearly twice as much as wooden tanks. In both cases, care must be taken to keep the tank painted, clean, and tight.

Wooden tanks are generally thought to be better than metal ones. They are easier to erect; they neither sweat nor rust; they do not follow temperature changes so readily; and they are less likely to freeze. As they cost much less, wooden tanks are much more common, even in the very large sizes.

Whether the tank should be inside or outside, depends largely on local conditions. The inside tank is restricted in size, both because of the limitations of the space available and, also, because of its great weight and the necessity of making special provision for its foundation support. On the other hand, it can be more readily protected from freezing in winter and overheating in summer. The life of wooden tanks is found to be seldom less than 15 years, and it is frequently 25 years or longer. Under inside conditions, the higher figure may well be reached.

Usually, the outdoor tower with tank is the most expensive construction. Placing the tank on the windmill tower is just as satisfactory, if a sufficiently high mill be used; and the cost is less than for a separate tower or for indoor construction. Frequently, however, the height necessary to give water everywhere cannot be reached except by means of a separate tower.

## Characteristic Features of a Desirable Mill

The power of any mill depends on a multitude of variable features, not only of construction and operation, but of atmospheric conditions. The size of the wheel does not necessarily indicate the power. The larger the wheel, the slower the speed at which it operates. For example, a 10-foot-diameter wheel has a rated speed of about 70 turns per minute; a 16-foot wheel 60 turns; an 18-foot wheel 45 to 50 turns; a 25-foot wheel perhaps 35 turns. Some of the mills run faster than this. Under average conditions, the horsepower developed may be from one sixth horsepower for the smaller wheel in a stiff breeze up to, perhaps, $1\frac{1}{2}$ horsepower or more for the larger. This is only suggestive, however, because in actual tests of 2 types of mills having wheels of the same diameter, operating in the same wind, one has been found to deliver twice the power of the other.

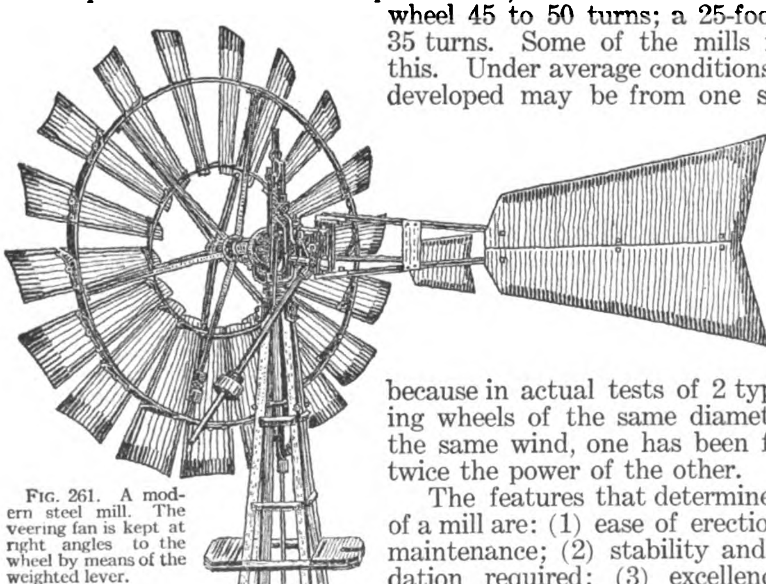


FIG. 261. A modern steel mill. The veering fan is kept at right angles to the wheel by means of the weighted lever.

The features that determine the desirability of a mill are: (1) ease of erection, handling, and maintenance; (2) stability and nature of foundation required; (3) excellence of design as regards both engine and pump; (4) regulation and degree of automatic action; (5) efficiency as determined by size and output; and (6) cost.

In connection with the first feature, low towers, say 40 feet and under, can be assembled on the ground and raised complete, including sails, while larger towers require piece-by-piece construction. In any case, a concrete base, to which the tower may be anchored, is very desirable.

In a brisk wind, using a 2-inch water cylinder, a 10-foot wheel of average manu

facture, geared 3 to 1, will make a lift of 250 feet; with a 3-inch cylinder it will lift 150 feet; and with a 4-inch cylinder it will lift 70 feet. A 16-foot wheel with a 3-inch cylinder will lift 500 feet and with a 4-inch cylinder will lift 300 feet. A 20-foot wheel with a 3½-inch cylinder will lift 800 feet; with a 5-inch cylinder it will lift 375 feet; and with an 8-inch cylinder it will lift 125 feet. The actual amount of water delivered depends on the number of strokes per minute of the pump and its efficiency (Chapter 14).

There is no doubt that the windmill in the central and western states, with a reasonably constant supply of wind, is the cheapest power on the farm. It must be utilized in small units. Even for power mills, as distinguished from pumping mills, sizes never run above a few horsepower output, while, in pumping mills, it is unusual to find even 1-horsepower capacity. The cost of such power is very difficult to determine with any degree of accuracy. It is not sufficiently low to justify any attempt to use it for continual power output in localities where some form of storage must be provided in combination with the windmill. It is best adapted and is cheapest for intermittent work. This includes pumping water, grinding grain, irrigating, and even wood sawing, if the wheel is large enough.

**Protection in winter.** There is need for considerable care in installation, where the windmill is to be used throughout the year. Particularly is it desirable to see that the pump cylinders and pipes are protected from freezing during very cold weather. This is best done by keeping all pipes below the frost line and by sinking the pump to a corresponding depth. Where any part is exposed, it is desirable to use a wrapping of felt or heavy stuff, or to fashion a casing which may be filled with sawdust, rags, crumpled paper, or similar substances. In the case of long, exposed pipe lines, it is desirable to place valves so that the water may be shut off and the pipes emptied on specially cold nights.

**Cost.** The cost of the various types of windmill varies widely, from $60 in normal times for a small mill on a 30-foot tower to, perhaps, $2,500 for one of the finer English mills of 30-feet diameter on a 40-foot tower. Such short towers are usually not desirable, except in open country; and even then dissatisfaction is apt to result from their purchase. Not only is the velocity of the wind less uniform near the ground surface, but it is actually very much less than the velocity higher up. At 100 feet, the velocity is normally nearly twice that at 25 feet. Therefore, a mill on the higher tower may give 4 or 5 times the power output of the same wheel on the short tower. With the higher towers, the normal cost of a substantial windmill would be from $250 to $500. This is, of course, a very considerable investment for so small a power plant. It is feasible, therefore, only where the prevailing winds are sufficiently strong and constant to give fairly constant power at the times when power is required. When this is true, the cost of the power is the interest on the investment plus depreciation of the machinery, plus the cost of oiling, painting, and occasional inspection. This will, probably, amount to about $60 or $70 per year for a $500 mill. From a knowledge of windmill performance it is conservative to assume that this outfit in the Central or Middle West would give a yearly output of at least 3,000 horsepower hours, and in favorable localities, would approach 5,000 horsepower hours. In the East, not more than 1,200 to 1,500 horsepower

FIG. 262. Side view of a small turbine windmill successfully used on the Great Plains. (Cornell Countryman IV-4.)

hours could be estimated. At this figure, the cost of windmill power would vary from a minimum of perhaps 1¼ cents per horsepower hour in the West to perhaps 5 cents per horsepower hour in the East. This would indicate that in the western windy states, the cheapest form of power is the windmill, as nothing else, except, perhaps, a water-power installation, can approach 1¼ cents per horsepower hour for small power users. In the East, however, the cost is approximately the same as for gasoline and steam power, though somewhat greater than the cost of kerosene power. The choice, then, is a matter of convenience. If the larger power plant is in use anyway, the windmill may be dispensed with. If a small power is needed intermittently and without constant attendance, the windmill may work out to the best advantage.

**Homemade windmills.** To give a small amount of power and for a corresponding small outlay of money, the homemade windmill is worthy of consideration in states where the prevailing winds are pretty definite in direction. The jumbo type and the battle-ax type of windmill are both usually built fixed in direction, but the latter type may be mounted with a vane to veer the head into the wind. The construction is all wood, and, depending on size, may cost anywhere from $2 or $3 up to $30, not counting labor or such material as is usually found on a farm. The battle-ax type may be extended into a straight vane turbine, a cheap type of which is shown.

The shafts of these mills are usually wooden, some smooth pole serving the purpose or, if available, a short rod or piece of pipe may be driven into the ends of the shaft proper to serve as bearings. The wheels or sails and tower structure can be made of poles, with sides of old boxes for vanes.

All of these types must be built fairly large, to give appreciable power, but, with diameters from 8 to 12 feet, they will show results. Such a mill should pump water sufficient for 50 to 100 cows to a height of 10 or 15 feet, if there is sufficient storage capacity to permit the mill being fully utilized.

**Care of the windmill.** In the so-called self-oiling types of windmill, oil magazines or reservoirs are provided which, when filled, will supply sufficient lubrication for from 4 to 6 weeks during the usual operation of the mill. If the mill is not self-oiling, it should be lubricated after each 8 or 10 hours of use. If a considerable period of time elapses before this amount of use, oiling should be done about twice a week. At each oiling, go over the mill, wrench in hand, and tighten any loose nuts or bolts. Note the condition of the structure, and, when rust appears, use paint.

FIG. 263. Giant battle-ax windmills used in irrigating a 15-acre Nebraska orchard. Costing $25 each to make, they will average about 1,000 gallons an hour each in a 15-mile wind. (Cornell Countryman, IV-4.)

# CHAPTER 16

# Water Power on the Farm

*By* Professor R. P. Clarkson *(see Chapter 14). The farmer who has on his property, or within convenient reach of it, a permanent stream has at hand a source of power that is constant, uniform, and easily harnessed either for the driving of machinery or the production of the more easily carried electric power (Chapter 19). Water has thus been used by man for many ages, yet even to-day, millions of units of power are being wasted because of insufficient knowledge as to how to capture and apply them. The data given here will enable the farmer to do a good deal; it should also stimulate him to learn and to do still more.*—Editor.

On any farm where there is a flowing stream, a pond, or a lake, the question of water-power possibilities should be carefully investigated. The requirements for power are, first, a supply of water continuous during the time power is needed, and, second, a drop or fall between the level where water is available and the place where it must be discharged. This is called the "head" of water. A very small head, or difference in level—even a few feet—is all that is necessary. The power obtainable depends upon three factors: (1) the weight of water which can be used per minute; (2) the fall, or head, available; and (3) the efficiency of the water wheel used. While it is well for the farmer himself to make preliminary investigation into the possibility of power, good engineering advice should be employed before any considerable amount of money is spent.

**Head.** This can usually be measured directly without difficulty, by means of the farmer's level. If the water supply is a lake which can be discharged through a wheel into a stream at a lower level, the head is measured between the two water surfaces. If the supply is a stream, the measurement of fall may be more complicated. A dam will probably be necessary to back the water up and form a storage pond. The head is then measured between the water surface of this pond and the surface of water in the stream at the point where the wheels discharge.

Usually, if a stream is being considered, there must be a rather quick drop, as indicated by swiftly flowing water, or the power probabilities will not be large. If there is a considerable drop, 2 points are chosen between which the main fall takes place. Call the upstream point A and the downstream point B. A dam is erected at B, sufficiently high to back the water up to the level at A and make available the fall or head from A to B.

**Water flow.** After head is determined, measurement must be made of the water flow between the two points. Unless measuring apparatus, such as a current meter, is available, the simplest way is as follows: Pick out a stretch of stream which does not vary greatly in width. Say the stretch is 200 feet long. Measure the width of the stream in feet at 10 stations along this stretch. At each station take 10 measurements in feet of the depth of the stream, spacing the measurements equally from shore to shore. Average the depth measurements at any one station and multiply the average depth by the width

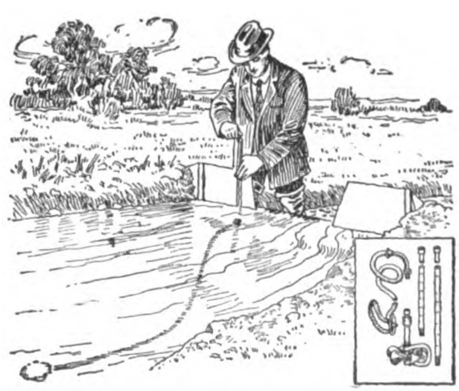


Fig. 264. An automatic measuring instrument being used to determine the depth of water on a weir. The inset shows one form of current meter sometimes used in place of the weir system of measuring stream flow.

FIG. 265. In measuring the flow through a weir with a simple straightedge, take the depth far enough back of the edge to avoid the surface curve of the water.

of the stream at that station. This will give the cross section in square feet. Get this cross section at each of the stations and average these 10 cross sections. This will give an approximate average cross section of the 200 feet stretch of stream chosen. If this is multiplied by the average velocity of the stream in that stretch, you will have the approximate flow of the stream in cubic feet per second. This velocity may be observed by noting the time taken for a chip to float the stretch of 200 feet, or, perhaps, an easier way would be to notice how far a chip will float along the stretch in 1 minute or in half a minute. Make 15 or 20 trials with floats, and get the average velocity of the stream—that is, the feet per minute covered by the floats. To be safe, take two thirds of this float velocity and multiply by the average cross section of the stream, to give the discharge in cubic feet per minute. The following table shows the amount of water required theoretically to give 1 horsepower with various heads. Twice the quantity will give 2 horsepower, 3 times the quantity will give 3 horsepower, and so on.

WATER REQUIRED THEORETICALLY FOR ONE HORSEPOWER

| HEAD IN FEET | CUBIC FEET PER MINUTE |
|---|---|
| 5 | 105.6 |
| 10 | 52.8 |
| 15 | 35.2 |
| 20 | 26.4 |
| 25 | 21.1 |
| 30 | 17.6 |
| 35 | 15.1 |
| 40 | 13.2 |

Practically, the horsepower will be only a fraction of that indicated, as some power is used up in the machinery and some is wasted entirely. The exact proportion of theoretical power obtainable depends upon the type of water wheel used.

To calculate quickly the horsepower of a stream or fall, engineers are in the habit of using a short and quite accurate method, as follows: *Divide the flow of water in cubic feet per second by* 11 *and multiply by the head.* The result gives the horsepower which may be developed, using a wheel of 80 per cent efficiency. If, for example, a head of 9 feet is available with a water flow of 22 feet per second, the horsepower which may be developed with a turbine of 80 per cent efficiency is found by dividing 22 by 11 and multiplying by 9, the result being 18. To find the horsepower of falling water exactly, multiply the weight in pounds of water falling per second (a cubic foot of fresh water weighs about 62½ pounds) by the head in feet. This gives the foot pounds per second. Divide the foot pounds per second by 550 to get the theoretical horsepower available.

## Water Wheels

For small, low-priced installations the gravity type of wheel is frequently used. Wheels of this type are operated directly by the weight of falling water exerted through the falling distance or head. Such are the breast and overshot wheels illustrated. The undershot wheel is operated by the current and involves no dam or other works. It is the old-fashioned mill wheel. The Pelton wheel is an impulse type, being operated by a jet of water forced against the blades of the wheel. Turbines of various kinds are also used. They are the most efficient type of wheel for low heads and are most generally used in commercial plants. They may be of either the impulse type, in which the direct force of the water against the moving part is used, or the reaction type, in which the back "kick" of the water as it leaves the vanes, furnishes the driving force. This kick is commonly used in rotary lawn and garden sprinklers, which are really reaction turbines.

The efficiency of wheels may be stated as follows: Undershot, 15 to 25 per cent; breast, 55 to 65 per cent; overshot, 65 to 75 per cent; Pelton, 75 to 80 per cent; turbine, 80 to 90 per cent.

A fall of from 6 to 8 feet and upward usually makes a turbine installation advisable, if considerable water is available. Under very small heads, of only 2 or 3 feet, undershot and breast wheels may be desirable, or, if conditions permit, an overshot wheel may be adopted. Where the undershot wheel is used, the stream is frequently narrowed to about the width of the wheel, thus giving the wheel the benefit of all the water in the stream running at a somewhat higher velocity than in the open stream. This type of wheel is rapidly disappearing altogether. One of its strong features, however, is its comparatively low cost, no dam being required.

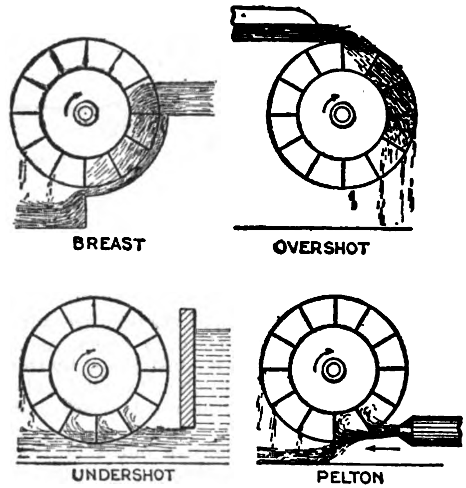


Fig. 266. Types of water wheels. The overshot is the most efficient of the simpler forms, but where there is much fall the necessary size (the diameter equalling the fall) may make it impracticable.

Recently an entirely new type of turbine, known as the Clarkson current turbine, has been invented. This is operated by the current flow and requires no dam, thus having these advantages in common with the undershot wheel. Its efficiency, however, is very much greater than that of the undershot wheel, and may run up to 60 per cent or more.

Just what installation is best in each case, and the cost involved depend upon local conditions. Before determining the size of wheel to install, the conditions of water supply at all seasons of the year must be taken into account. Some streams, for example, have large quantities of water available for a few months of the year, and for the remaining time are either frozen or completely dried up. Such streams are obviously unsuited for continuous year-round power purposes. In commercial installations, the flow of such streams is often equalized to some extent by the utilization of big storage reservoirs which can be drawn upon in time of drought; but for small installations, this arrangement can usually be only sufficient for day-by-day regulation, and cannot take care of seasonal water shortage.

**Cost of water-power plants.** The cost of a small water-power turbine plant may range from $50 per horsepower, where conditions are unusually favorable and the power is used directly, as for sawing, grinding, or other purposes, up to several hundred dollars per horsepower, where a large dam is required and electric generators are installed to give a supply of electricity for lighting and other purposes. The following table* gives some figures about successful farm water-power plants in various parts of the country. All of these are turbine plants.

While nothing very definite can be said about cost, it is usually true that, with other conditions unchanged, the higher the head, the less the cost. The larger the plant, the less it will probably cost per horsepower.

*From "Practical Talks on Farm Engineering," by R. P. CLARKSON. Doubleday, Page and Co., Garden City, N. Y.: 1915.

FARM WATER-POWER PLANTS

| HEAD | POWER DEVELOPED | LENGTH OF DAM | COST OF PLANT |
|---|---|---|---|
| 6 | 17 hp. | 36 feet | $1,000 |
| 11 | 8 hp. | 350 feet | 1,000 |
| 15 | 5 hp. | (used old dam) | 225 |
| 17 | 15 hp. | 200 feet | 700 |

In most cases under normal conditions, from $100 to $125 per horsepower will cover the cost of the entire installation, including electric machinery, wiring, lights, etc. The cost of operation is the interest and depreciation on the plant, the expense for oil and repairs, taxes, and such supervision as is necessary.

On the other hand, plants using the gravity


FIG. 267. Stream viewed from above to show where dam and turbine should be located. With sufficient water available, a supplementary, simple water wheel could be located at the dam.

or current types of wheels, where they are suitable, may cost only a third as much as a turbine plant or even less if constructed by the farmer himself. They involve, usually, only wooden construction or, at most, wood and concrete.

When a simple, inexpensive outfit of this kind has proved the importance and value of power development to you and your household, then you may feel more inclined toward the expenditure required for a good, permanent turbine plant, if conditions permit. It should be remembered that additional convenience and the saving of unnecessary labor and trouble are all sufficient to warrant considerable outlay and are truly as valuable as the more direct saving of money.

It must not be assumed that a water-power plant is necessarily the cheapest way to get power. It may be neither the cheapest in first cost nor the cheapest to operate. In fact, water-power plants are usually more expensive to build and install than steam plants or gas and oil engines. Water-power installations are sometimes so very costly at the beginning that the very heavy interest and depreciation charges, taken together, with the maintenance and operation costs, make the cost of the power produced greater than that of such power when supplied from other sources. These items of interest and depreciation should properly be considered always as part of the cost of power.

The thing to keep in mind is the cost per horsepower hour for the power you can use. This must be modified somewhat by the feature of convenience. Simple farm water-power plants require almost no continual attendance. No damage, except to the immediate machinery, can result even from gross neglect. The installation may be practically noiseless. These are some of the points—frequently deciding factors—which differentiate water-power plants from either steam, gas, or oil installations. The discussion of these alternative types of power plants may be found under their respective headings later on in this volume.

## The Hydraulic Ram

One of the more important problems of country life is the supplying of water in plentiful quantities for use in the house and barn. Laborious hand pumping and frequently, also, the carrying of water by hand are resorted to on many farms. Windmills are commonly used for pumping purposes and make very satisfactory pumping engines. Of course, any form of power can be utilized to run a pump, but one of the cheapest and most satisfactory, as well as almost foolproof, machines for pumping is the hydraulic ram. It will operate at high efficiency continuously without any attendance.

To the average person, the hydraulic ram is a mysterious thing. Working day and night for years without attention and without rest, it is the farmer's most dependable friend for pumping water. The efficiency of the ram, when used for lifting water only 4 or 5 times as high as the fall, is as great as that of the best pumps, and is much better than that of most pumping apparatus. For other ranges, where the lift is small up to 25 times the fall, table A gives the efficiency of a ram.

TABLE A

| | | | | |
|---|---|---|---|---|
| Lift divided by fall . | 2 | 3 | 4 | 5 |
| Per cent efficiency . . | 90 | 85 | 80 | 75 |
| Lift divided by fall . | 10 | 15 | 20 | 25 |
| Per cent efficiency . . | 57 | 42 | 30 | 23 |

The efficiency of a ram falls off so greatly as the delivery height increases that rams are seldom used where the lift is more than 25

FIG. 268. Rough stone dam (*in background*) creating a head with which to operate ram (*at left*), the delivery pipe from which is seen in the foreground.

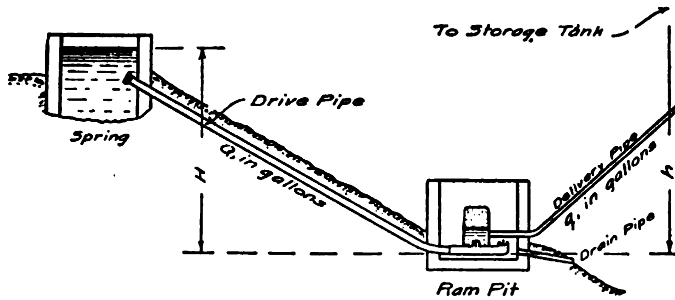



FIG. 269. Diagram to show relative positions of spring or supply tank, drive pipe, ram in ram pit and delivery pipe. The letters are the same as those used in the efficiency formula as given below.

times the fall. For what are known as "common rams," the general rule for calculation is that one sixth of the water supplied to the ram will be lifted to a height 10 times as great as the fall. Exact calculation may be made for any ram by using the following formula:

$$q = \frac{Q \times H \times e}{h}$$

where $q$ equals the quantity of water raised, in gallons, Q is the quantity supplied to the ram, in gallons; $h$ is the lift from ram to storage tank, in feet; H is the fall from supply down to ram, in feet; and $e$ is the efficiency of the ram taken from Table A, page 176, where $h$ divided by H is the lift divided by fall.

For example, there is a fall of 10 feet, and ram can be supplied with 25 gallons of water per minute. The storage tank is in the attic 40 feet above the ram. How much water per minute will be supplied to tank? From Table A, the ratio of 40 feet lift to 10 feet fall will permit an efficiency of 80 per cent. Then, using the figures given and substituting them in the formula:

$$q = \frac{25 \times 10}{40} \times 80 \text{ per cent} = 5 \text{ gallons per minute.}$$

It is apparent that if 25 gallons of water are delivered to the ram and only 5 gallons reach the tank, there must be a great waste of water. The water is wasted, but the energy of its fall is utilized in lifting the remaining quantity to the greater height.

A diagrammatic form of ram is shown on page 178 (Fig. 271). There are five main parts: the drive pipe A, the waste valve B, the delivery pipe D, the air chamber C, and the admission valve E. The water flows down A and out of the waste valve B, when the ram is first started. When sufficient velocity has been gained by the water, it closes valve B suddenly. This confines the water in the casing and, as the movement of such a large bulk of water cannot be stopped instantaneously, the valve E is dealt a hammer blow which opens it and allows a small amount of water to flow into the air chamber. The valve E then falls shut again and, then, as the water has slowed down, the waste valve B again opens, the water flows out, gains velocity, shuts the valve B again, opens valve E, and more water is forced into the air chamber. This action continues indefinitely as long as water is supplied to the ram.

**TABLE B: SUPPLY REQUIRED TO DELIVER ONE GALLON PER MINUTE**

| | | | | |
|---|---|---|---|---|
| Ratio of lift to fall . . . | 2 | 3 | 4 | 5 |
| Gallons per minute required to operate ram . | 2.22 | 2.47 | 5.00 | 6.67 |
| Ratio of lift to fall . . . | 10 | 15 | 20 | 25 |
| Gallons per minute required to operate ram . | 17.54 | 35.91 | 66.67 | 108.70 |

The presence of air in the chamber C is necessary; for it compresses when the sudden blow is struck on the valve E, and this allows

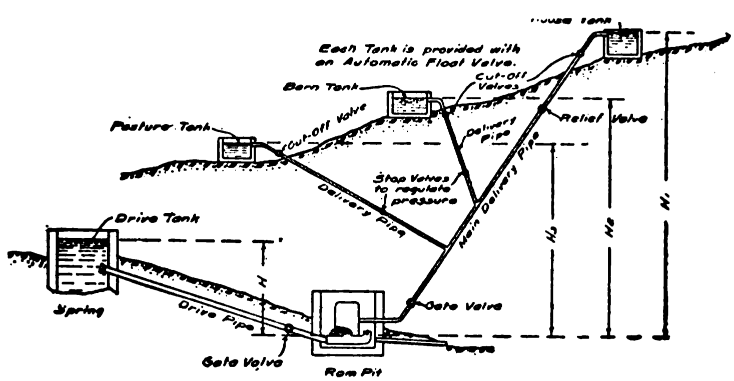



FIG. 270. Showing how one ram can be used to supply three different tanks at three different levels

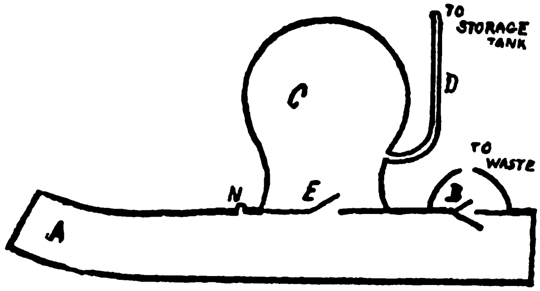



FIG. 271. Diagram made as simple as possible to show parts and operation of the hydraulic ram (see text)

that valve to open. Of course, the water will absorb a little of the air, and after a time the air in the dome will be exhausted. This will cause the ram to stop; and, to prevent such stoppage, there must be a way of admitting more air into the air chamber. This is done by boring a small hole at N. The water, rushing into chamber C, sucks in through the hole N just a tiny bit of air, enough to prevent the exhaustion of the air chamber. On many of the higher-priced rams, a "sniffer" valve is located at some such point as N, to serve the same purpose as the tiny hole here recommended.

The ram, as described above, will raise a portion of the water supplied to it to any desired height. If, however, it is desired to pump clear water from a brook or spring by means of undesirable water from some pond or stream, it may be done with safety by using a ram-pump. This resembles the ram shown except for the addition of the parts H, K, V, and S, as shown in Fig. 273. As before, the water to operate the ram comes through the drive pipe, but the water to be pumped enters through the small pipe K, and passes through the valve E, when the latter is opened. A check valve at V prevents the clear water being forced back up the pipe K, while a stand pipe at S keeps sufficient water pressure on the pipe at H to fill the righthand end of the casing at all times and even to allow a little to leak through the waste valve B. Thus, none of the impure water gets near enough to the valve E to be in any danger of being forced into storage. The ram-pump is best used where the supply of pure water is decidedly limited in quantity.

Rams and ram-pumps are usually placed at the bottom of pits dug into the ground, the head being increased in that way while the waste water flowing from the waste valve is easily drained from the pit through open-joint tiles or through a drain pipe laid from the pit to a lower level.

Rams are commonly made in 6 sizes, from that requiring only 1½ gallons per minute to operate it up to one requiring 25 gallons per minute. The price ranges from $5 up to $25 for these sizes. Larger sizes are made, and often a whole battery of rams is installed where the supply of water is large. Rams so combined may deliver through a common pipe or through individual pipes leading to as many tanks. Similarly one ram may be made to supply more than one container as shown in Fig. 270. Ram-pumps are slightly more expensive. If possible, the ram to be purchased should be provided with an adjustable arrangement on the waste valve, so that the latter will not stick if a higher head is used than was at first thought to be possible. If this is not done, care must be taken that the ram bought is workable on the highest head of water that is likely to be employed.

FIG. 272. Small concrete spillway to take care of the surplus water above that needed to operate a ram or wheel.

## The Siphon

Occasionally, it is necessary to carry water for use up over the top of an intervening ridge. This may be done without continuous pumping by means of a siphon, provided (1) that the lift required from the surface of the supply pond or stream to the top of the ridge is not more than about 25 feet, and

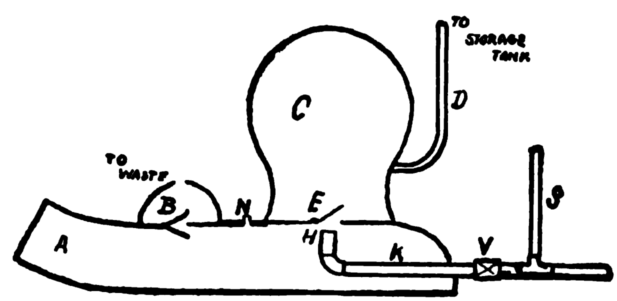



FIG. 273. Simple ram varied by the addition of parts H K V and S so that a large head of impure water can be used to elevate pure water from a smaller supply.

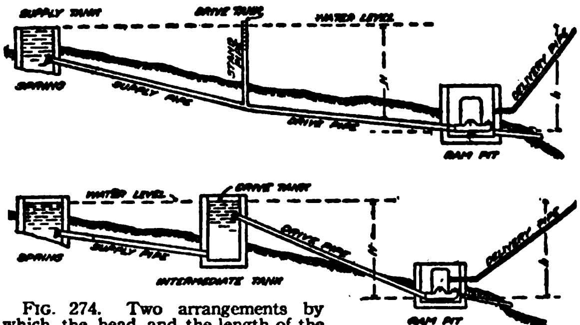


FIG. 274. Two arrangements by which the head and the length of the drive pipe can be brought into correct relationship. It is the height of the water surface, not its extent, that determines its pressure.

(2) that the discharge point of the siphon is below the level of the supply pond.

In theory, the siphon may be made so that the lift from the surface of the supply pond to the topmost point of the siphon would be 34 feet, but in practice it is very difficult to get anything like this height without special care and precautions. The large number of joints, their possible leakage, the friction loss of the water flowing in the pipe, all combine to lower the possibilities. Also, in high altitudes the atmospheric pressure, which causes the siphon to operate, is much less, and the height to which the water can be raised is less in proportion.

For temporary use, any sort of flexible pipe as, for example, a garden hose, makes a very satisfactory siphon. The siphon principle may be used to empty barrels or tubs where it is not desirable to use a spigot; but the barrels should be raised, so that the discharge end of the hose will be kept below the surface of liquid in the barrel. Similarly flooded cellars and basements may be emptied without pumping, if the discharge end of the pipe can be put below the surface of the water in the cellar, as is frequently possible if the house stands on a hill.

Often a siphon, ingeniously used, will do away with an expensive pumping outfit; and it not only costs less to install, but will operate at practically no cost and without any attendance.

A successful siphon must be air-tight, and the supply end of the pipe must be kept below the water surface. Preferably, there is a valve at each end of the siphon, the one on the entrance end being below the water surface and that on the discharge end, which may indeed be a faucet, being materially below the level of the other one—5 to 10 feet or more is advisable. At the very topmost point of the siphon, there should be a short standpipe connected with the siphon; and it, too, should have a good valve in it.

The diagram (Fig. 275) shows the arrangement for supplying a barn from a pond located on the other side of a hill. To start the siphon, close the valves at the ends of the pipe A and C, open the valve at B, and fill the pipe completely until it overflows the standpipe. Then shut valve B as tight as possible. The


FIG. 275. Diagram to show working of siphon (see text)

siphon is now full of water, and if the valve or faucet at C be opened and that at A opened at the same time—not before C—the water will flow continuously from A up over the hill and out at C. The valve A and B must not be touched; but the flow must be regulated entirely by C, which may be opened and closed like any faucet. If at any time there is leakage of air sufficient to stop the action of the siphon, careful repairs must be made, and the siphon must then be started as before by filling through B.

In most cases, the distance from the surface at A to the top point below B cannot be much more than 25 feet, but the distance from the top point below B down to the discharge at C may be anything. The difference in levels between A and C should be at least 4 or 5 feet and preferably more. A very small pipe should not be used for siphoning, as the friction is greater in proportion than with large pipes, and a very small leakage of air which might not affect the operation of pipes of considerable diameter would operate to stop the smaller siphon entirely.

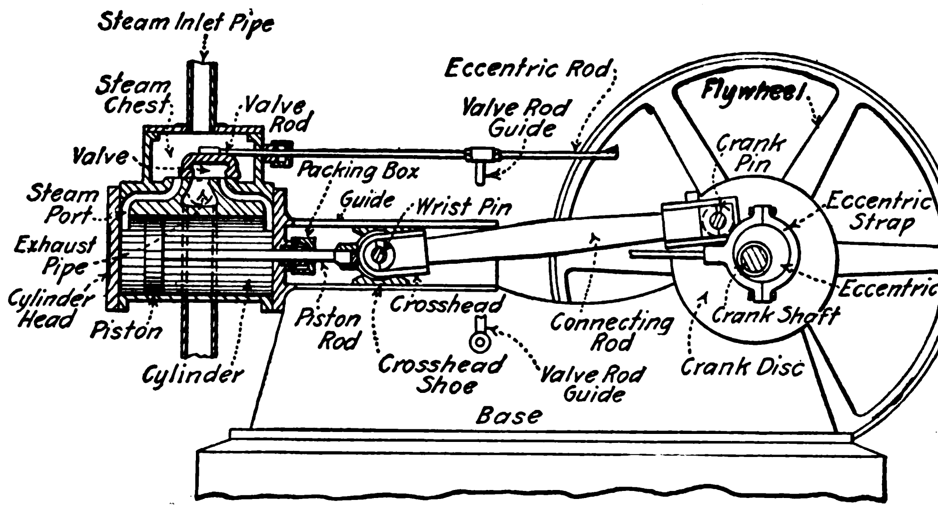



FIG. 276. Sectional diagram of a horizontal steam engine with important parts named

# CHAPTER 17

# Steam Engines

*By* PROFESSOR R. P. CLARKSON (*see Chapter 14*). *The most extensive use of steam on the farm to-day is probably in connection with the heating of greenhouses and the washing and sterilizing of dairy utensils, etc. It should not be overlooked, however, as a source of power (preferably stationary, but also, where conditions are favorable, in tractor form) because of the simplicity of the principles by which it operates, and of the comparative cheapness of the maintenance of a steam power plant. Moreover, when such an outfit is operated, there remains the exhaust steam with its value almost undiminished as far as heating the house, work buildings, greenhouses, etc., is concerned. For some years the steam tractor hauled, unchallenged, the huge gang plows and the mighty seeding and harvesting implements that paved the way to the profitable cultivation of the western plains. Now the lighter, more easily fed internal combustion tractors have stepped in and largely displaced the pioneer. But it still has its place, both on large farms and small, and the farmer can well afford to familiarize himself with its requirements and its fields of service.*—EDITOR.

IN ANY discussion relating to farm power, it is necessary to consider not only the very common internal-combustion, or oil, engine, but, also, the less frequently seen steam engine. The great advantage of the steam engine lies in its flexibility of power output. By increasing the boiler pressure of steam, you make possible a very great overload or increase in engine power. A so-called 10-horsepower farm engine may thus be made to give 25 or 30 horsepower for a time, with, of course, a corresponding increase in steam consumption. This cannot be done with any other type of engine or motor. The output of kerosene and gasoline engines is definitely limited by certain features of their construction.

Another and, in some cases, an important advantage in the use of steam power is the possibility of using the exhaust steam about the farm to heat water for washing or other purpose or for the heating of the house, shop, or other buildings. Where these things are desirable, steam power must be considered.

It is seldom advisable to purchase small-sized steam plants—2- or 3-horsepower—as they are almost invariably carelessly and poorly made and, at best, extremely uneconomical. Even comparative economy of operation of steam equipment cannot, in fact, be reached in anything short of 20 or 30 horsepower;

and even this size of plant suffers by comparison with a kerosene-engine outfit, except in the special cases mentioned above.

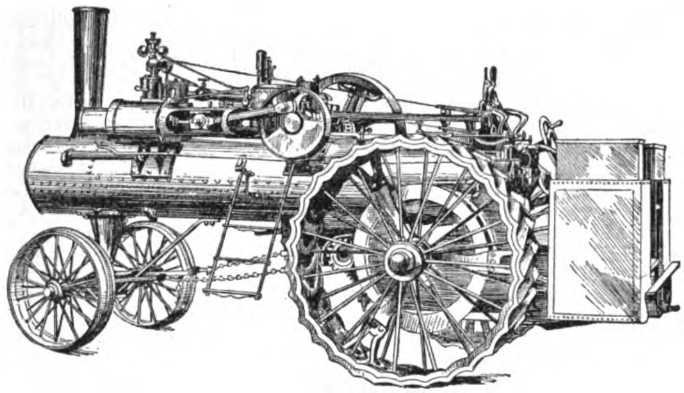


FIG. 277. The steam tractor is powerful, reliable and simple to run and care for. Its chief disadvantages, compared with the gas and oil types, are its frequent need of water and the bulkiness of its fuel.

In attendance and care required, the steam plant is more exacting than any other source of power. In cost of operation, including labor, it is usually more costly. A great disadvantage lies in the fact that initial labor and considerable fuel consumption take place before the plant is ready for work in the morning; and, if it is worked up to its proper capacity, the end of the day finds a boiler full of steam and a fire pot full of partially consumed fuel. All this is wasted unless there is some secondary use for steam from the power plant.

The steam plant, although requiring a great deal of care and attention because of the possibility of explosion owing to too great a steam pressure, or of destruction on account of lack of water in the boiler, is not, as built for farm use, a very complicated outfit. There are several types, differing largely in degrees of portability. In the usual form, the engine is mounted directly on a horizontal boiler which, in turn, is on a light-wheeled frame. With this it is not possible to use economically the many refinements available for stationary plants, especially those used in large-sized stations, such as are found in our towns and cities for electric lighting.

The essential parts of any steam-power plant are: (1) a boiler or container in which water can be heated to steam and (2) an engine in which the steam can be made to expand and exert pressure continually. These are the only fundamental parts. There are all sorts of additional arrangements and devices used with each part of the plant, either to save labor or to insure safety of operation. On the boiler, for example, there is a gauge glass to show directly the height of water, and try cocks to indicate by trial the presence of water in its proper place and steam in its place. There is always a pressure gauge to show what the steam pressure is, and a safety valve which operates and releases the steam, if the pressure becomes too great for safety. Usually, an additional safety device, called a fusible plug, is installed. This plug is arranged to melt, if the water gets too low and the boiler thus becomes too hot. When the plug melts, the steam blows on the fire and puts it out. Some boilers are fitted with a feed-water heater which heats the water before it goes into the boiler, the heat required being usually furnished by the exhaust steam from the engine and occasionally by the hot gases passing up the smokestack. The latter arrangement is called an "economizer," and is seldom found in any but large stationary steam plants.

## Boilers

**Water-tube and fire-tube types.** The steam boiler, which is usually cylindrical in shape for small installations, may be either vertical or horizontal. The vertical type saves floor space and is most used indoors. Sometimes the water circulates through a network of pipes which are surrounded by hot gases from the fire. This is called a water-tube boiler. Very often the water is in a large container through which a number

of tubes or flues pass, these tubes carrying the hot gases through the mass of water on their way to the smokestack. This is the fire-tube type. In this type, also, the fire box is almost entirely surrounded by water.

**Locomotive type.** The locomotive type of boiler is most used for portable purposes and is always used on steam tractors. It is a horizontal, fire-tube type, with an enlargement of the shell of the boiler at one end to form the fire box. The water surrounds the fire box. Above the water space and attached to the top side of the cylinder is a small chamber, called the steam dome, from which the steam is drawn to the engine. This arrangement is made to prevent the steam, as it is drawn off, carrying water spray with it. The steam dome thus helps to make available dry steam. Occasionally, the steam drawn from the boiler is also passed through a collection of highly heated tubes, called a superheater, which raises the temperature above the normal boiling point of water.

**Grates.** The grate design depends on the fuel to be used. Most farm boilers have interchangeable grate riggings. The grate with smaller openings is used for cobs and wood and other similar fuels. Where straw is used, still further changes are made. The straw, being light in weight, is quick-burning, and flashy. To prevent its waste, deflectors are frequently used to prevent the draft carrying the flaming straw through the tubes, and a supplementary grate is used below the main grate to catch such particles as fall without being entirely consumed. Combustion of these particles is completed on this grate and thus a considerable heat saving is effected.

**Traction engines.** In many cases, particularly with traction engines, there is some way provided for increasing the draft and thus forcing the fire to burn more rapidly. The usual way is to exhaust the steam from the engine up the stack. The steam rushing up the stack under pressure creates a suction and draws air rapidly through the grate. Of course, when the engine is not running, live steam from the boiler must be substituted. When this is done, only a small jet is used. With forced draft on traction engines, some form of spark arrester is needed in the stack. This is usually a wire screen formed into a cone and filling the stack. Occasionally, a sharp turn in the smoke path is provided; and this separates the heavy sparks from the smoke. The heavy particles strike the side of the bend, lose their inertia, and fall into a receptacle placed to receive them. The smoke, however, being of a gaseous nature, makes the turn.

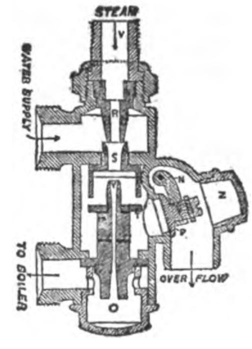



FIG. 278. Sectional view of one type of injector. When steam is turned on through V, it creates a suction in the narrow parts R and S, which draws water in through the supply pipe and starts it on its way into the boiler.

**Injectors.** To deliver water to the boiler without the use of a feed-water pump, the steam injector is sometimes used. It is practically universal in locomotive work; but in stationary plants it is not so frequent as a main method of delivering water. Small boilers are frequently equipped with some type of injector; and it is a desirable thing to know something about its use. In a sense, it acts like the atomizer spray. There are 2 intakes: one for steam under pressure and the other for water. The steam rushing in over the water intake partially exhausts the air and draws water up the tube. The steam condenses on meeting the water, and gives to the water considerable motion. The water is thus forced through a check valve into the boiler. This is the simplest form, and illustrates the action of all types. The troublesome features about the use of the injector are: (1) its inability to handle hot water because the vacuum action causes the water,

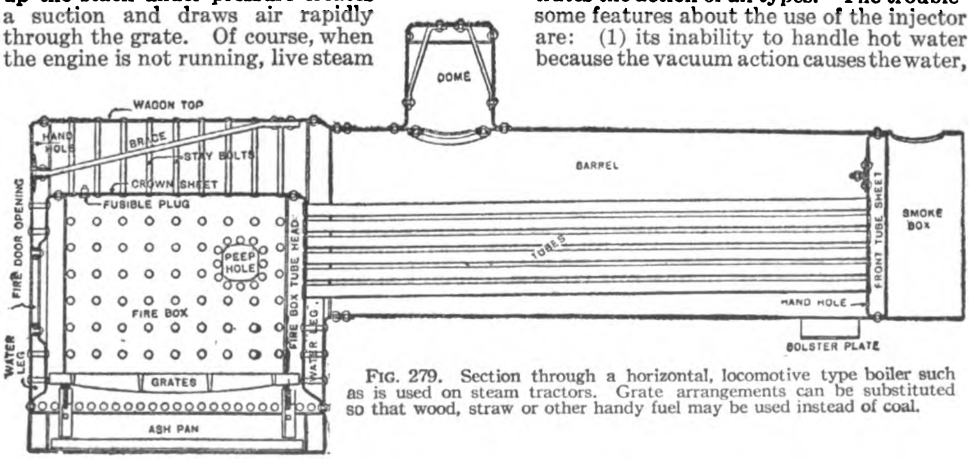



FIG. 279. Section through a horizontal, locomotive type boiler such as is used on steam tractors. Grate arrangements can be substituted so that wood, straw or other handy fuel may be used instead of coal.

if hot, to flash into steam; (2) the uncertainty of operation except under proper working conditions; and (3) its lack of flexibility, that is, the difficulty of maintaining it in operation under varying conditions of load. On the other hand, the injector is self-acting by means of the boiler pressure, and the steam used serves to heat the water as it is fed into the boiler. Nevertheless, even with these advantages, the injector is a great waster of heat as a mere pump. Its efficiency lies in its combination action as pump and feed-water heater. For these purposes, it is a proper device for small single-unit boilers, being less expensive, usually, than the apparatus which it is designed to replace.

**Care of the boiler.** Proper care of the boiler means attention to only 5 main points: (1) there must be a proper amount of clean water in the boiler; (2) there must be a deep, clean fire on the grate; (3) the pressure of steam must be kept reasonably constant at the proper gauge reading; (4) the boiler itself must be kept clean and in good repair; (5) all accessories should be kept in perfect working order.

Where water is dirty or impure, foaming is likely to result. The water will rise and fall in the gauge glass, the engine will lose power, and water is very likely to be carried over with the steam into the engine, causing a sort of clicking noise. If this condition persists, damage will result.

Almost all water has in solution something which is detrimental to the best operation of the boiler. Soft water is apt to eat into the boiler and accessories because of its probable acidity, while hard waters are sure to cause a scale. Continual cleaning of the boiler and the careful use of soda ash with soft scale is usually advisable. If the scale becomes hard, one of the many boiler compounds made for this special purpose is necessary.

To keep a deep, clean, bright fire all through, continual watchfulness is essential. Clinkers must be kept loose from the grate and the furnace cleaned entirely once in a while. The method of firing is important also. The fresh coal is usually placed near the door and spread back after coking. In this way a bright fire is maintained even when a fresh charge is put in, and the gases of the fresh coal are entirely consumed in passing over the bright coals in the rear. The principal disadvantage in this method of firing is the maintenance of an open door during the considerable time necessary for spreading; but quick and careful work will cut this time down to a minimum.

The two processes "banking" and "drawing" should be mastered. If a boiler is used constantly every day, it is usually considered more economical to bank the fire overnight, rather than build a new fire each day. Frequently, too, fires must be banked to prevent a rise in pressure during the day if, for example the fire is bright and the engine is shut down for a while. Banking is usually accomplished by covering the fire with ashes or screenings or fresh coal, and closing all drafts. Sometimes the fire-pot door is left ajar. Drawing a fire should never be attempted without first lowering the heat of the fire by smothering with dirt or ashes or, if need be, fresh coal. After smothering to some extent, the fire may be drawn rapidly without the terrific flare which would result if it were drawn while glowing. The fire should always be drawn to cool the boiler quickly or to remedy any condition caused by extremely low water.

The size of a boiler is usually stated in terms of capacity and the quality or economy of action. The former is given in boiler horsepower; the latter, in pounds of steam evaporated per pound of coal. The standards used vary considerably and are most unfortunate in many respects. The horsepower standard adopted by one leading engineers' society says that the equivalent of 1 boiler horsepower is the evaporation of 30 pounds of water at 100 degrees under a gauge pressure of 70 pounds. Another way of rating is to take from 10 to 14 square feet of heating surface of the boiler as the equivalent of a boiler horsepower. Still a third approximate method of rating, only occasionally used, is to consider one half a square foot of grate surface as equivalent to 1 horsepower. Except in the case of marine boilers, this rating has nothing whatever to do with the horsepower of the connected engine. In marine work, however, the horsepower of the boilers is uniformly spoken of as the horsepower of the engines which they serve.

The economy of boilers depends so much on the handling of them that little can be said about this feature. The amount of coal consumed in the average farm boiler per horsepower of engine output varies from 60 to 80 pounds per day with ordinary firing. With expert firing this could probably be cut down to perhaps 40 pounds. Such firing, however, is almost never available.

## Engines

Next to the boiler which furnishes the steam, the important link in the power chain is the engine which utilizes the steam. The former is essentially very simple. The latter, although it looks complicated, is in reality just as simple. In a cylinder of smooth bore a piston fits and slides freely to and fro. This piston

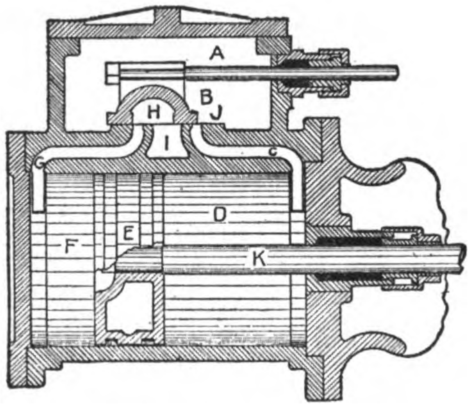



FIG. 280. Section through a steam engine cylinder and valve. Steam from the chest passes through the port (C) into the rear end of cylinder (D) and against piston (E) which it forces toward the front end (F). At the same time the steam previously used is forced out through port (G) into the exhaust chamber (H) and through port (I) into the air. By this time the valve (B) has shifted and begins to admit steam through (G) and let it out through (C), thus driving the piston back again. The piston rod (K) acts on the fly- or driving-wheel

is actuated by the live steam from the boiler, which is, of course, at a pressure, usually considerable; in stationary boilers of small size, it runs from 69 to 150 pounds gauge. This live steam is admitted to one side of the piston by a valve mechanism which, at the same time, opens the other side of the piston to the atmosphere or, in condensing engines, to more or less of a vacuum. Consequently, the force of the live steam moves the piston and thus operates the flywheel and the power shaft. The valve mechanism is operated by an eccentric on the power shaft or connected with it, so that when the piston reaches the end of its stroke the valve shifts to reverse the side on which the steam pressure acts. This reversal together with the momentum of the flywheel forces the piston back on the return stroke.

Various refinements of this valve mechanism are available, so that the steam may be admitted during varying lengths of time and then allowed to expand in the cylinder, thus reducing its pressure as it acts on the piston, and permitting exhaust at a considerably lower temperature and pressure. This results in much greater engine economy than if the steam were used directly at boiler pressure throughout the stroke. In this connection, it should be stated that the correct setting of the valves on an engine is probably the most important thing about the economical running of this mechanism. There are 4 points involved: (1) the opening of the port for the admission of live steam immediately before the piston reaches the end of its return stroke; (2) the cutting off of the live steam at the proper point for true economy in the work being done. This may be at one fourth or one third or one half of the stroke and does vary from time to time; (3) the release of the exhaust steam at the proper point, which is just before the end of the forward piston stroke; and (4) the closing of the exhaust port sufficiently early to retain a small amount of steam in the cylinder for cushioning purposes. This steam is compressed as the piston nears the end of the back stroke, frequently making the pressure against which the live steam is first admitted a considerable amount.

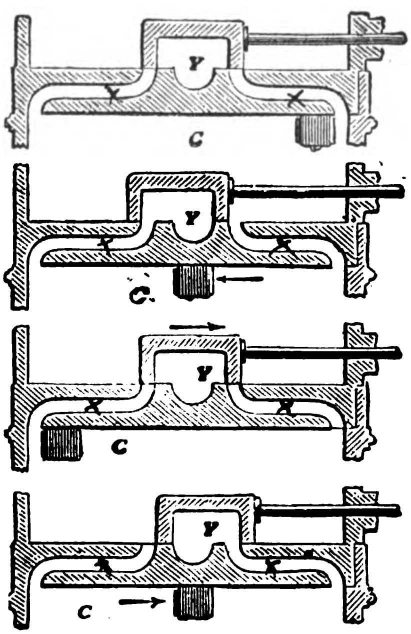



FIG. 281. The valve and ports of a steam engine illustrating the four positions referred to under Fig. 280. Here C is the cylinder, Y the exhaust chamber, and X the ports.

This process of obtaining power is very simple and, of course, very old; and it is, in fact, very wasteful. In some engines, less than 2 per cent of the heat supplied is avail-

able for useful work. In the best engines with all refinements, not more than 18 per cent is available. The great loss of heat is in the exhaust steam, which is discharged from the engine and can do no more useful work so far as the engine is concerned. If this source of heat can be adequately utilized for any other purpose, as described at the beginning of this article, the lack of engine economy is not so discouraging.

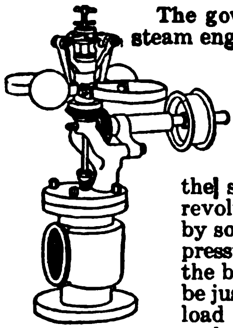


FIG. 282. Fly-ball type of governor by which the admission of steam into the cylinder is automatically regulated.

**The governor.** While in most steam engines the control of variations in speed during different parts of a single revolution is taken care of by the action of the flywheel, yet the regulation of the speed, revolution after revolution, must be handled by some control of the steam pressure. The supply from the boiler at all times must be just enough to handle the load without slowing down under heavy loads or speeding up under light loads. This is arranged in any one of a number of ways on various types of engines apt to be found on the farm. The governor may operate the throttle and act equivalent to changing the boiler pressure; it may act to cut off the live steam at some point in the stroke, and thus determine the expansion.

The common form of governor is the fly-ball type. The centrifugal action of rotation throws the balls out, and in so doing raises the slide and operates some type of valve. Promptness of action and delicacy of adjustment are essential features which must be looked after in design. The resisting force against which such a governor acts is the weight of the balls, although some types use a spring in place of depending on gravity action.

The location of the governor is not important, except as it avoids complication of machinery and action. If designed to regulate the pressure, it is usually placed on a vertical shaft, balls being suspended from the shaft by hinged arms or rods sloping to either side with the balls on their extremities, connecting links extending down to a sleeve which slides up and down on the shaft and operates directly or through mechanism to a valve on the steam line. In some cases the governor is placed on the flywheel, the weighted or spring-controlled arms being pivoted to the wheel spokes and operating directly a rod which affects the eccentric mounted on the same shaft. This eccentric determines the position of live steam cut off in the steam chest. The governor thus regulates the amount of steam admitted and the ratio of expansion in the cylinder. This type is called the automatic cut-off. It is perhaps more often found on high-grade engines which operate at high speed.

**Classifications of engines.** There are a number of classifications for engines which should be mentioned. The kind of work to be done determines whether the engine should be (1) stationary; (2) portable; (3) traction, or (4) marine. Their speed divides engines into (1) high-speed, and (2) low-speed. Whether the engine exhausts into the air or into some sort of condenser, determines it to be (1) non-condensing, or (2) condensing. Whether the steam goes on both sides or on only one side of the piston makes it (1) double-acting, or (2) single-acting. If the steam exhausts from the cylinder of one engine to a larger cylinder of another engine, built to utilize low-pressure exhaust steam, it may be a compound engine. Most farm engines are high-speed, non-condensing, single- or double-acting, and may occasionally be compound, though oftener they are single 1-cylinder rigs. Of course, stationary, portable, and traction types are frequently used.

**Measuring horsepower.** There are 2 values which are known as the "horsepowers" of any engine. One is called "indicated horsepower," usually written I. H. P., while the other is the "brake horse-

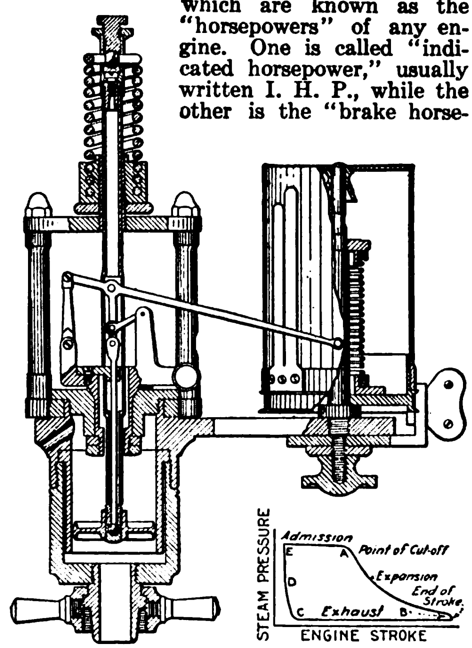



FIG. 283. Sectional view of an indicator for measuring the horsepower of an engine. The inset shows a typical indicator diagram or curve.

power," written B. H. P. The indicated horsepower of a steam engine is the mechanical work done in a certain time by the steam acting on the piston. Some of that work goes to run the engine itself, overcoming the friction of the bearings and the drag of the moving parts, so that only a portion of the force exerted can be delivered to the belt pulley. The work which can be done by this portion at the pulley in a certain length of time is the brake horsepower.

To measure the indicated horsepower of a steam or oil engine, an instrument known as the "indicator" is used (Fig. 283). There is a cylinder to which steam or explosion pressure is admitted from the engine cylinder. The pressure forces the piston back against the resistance of a coiled spring, which has been experimented with previously, so that the pressure exerted by the steam on the little piston is known from the amount the spring is compressed. As the area of the small piston is usually just one square inch, the pressure indicated by the compression of the spring is the pressure per square inch of the engine piston. So, if we multiply this indicated pressure by the total area of the engine piston, the result obtained is the total steam pressure on the engine piston. This varies continually, on account of the movement of the piston and the expansion of the steam.

**Indicator diagrams.** There is, also, on the indicator a rotating drum which turns through a distance proportional to the stroke of the engine piston. A pencil is so arranged that it moves up and down with the indicator piston; and as the drum rotates beneath the pencil the latter draws a diagram with its length proportional to the engine stroke, and its height proportional to the pressure on the engine piston. In Fig. 283 is shown the shape of such a diagram for a steam engine, which is known as an "indicator diagram." Oil-engine cards are similar, but narrow. Mathematical calculations show that the area of such a diagram as this is proportional to the product of the average pressure on the piston during the stroke and the length of the stroke. In other words, the area of this diagram is proportional to the work done on the piston of the engine by the steam during one stroke, so that, knowing the number of strokes per minute made by the engine piston, we may easily find the work done per minute. This, divided by 33,000, gives the indicated horsepower (I. H. P.) of the engine, because 33,000 foot pounds per minute equal 1 horsepower.

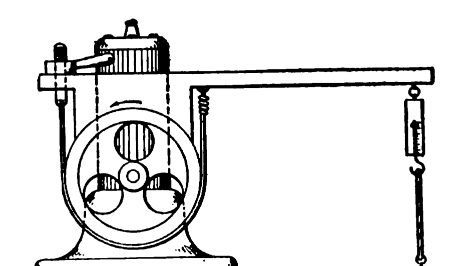


FIG. 284. One form of prony brake. The pull or weight on the arm, caused by the friction of the wheel against the belt is read on the spring balance shown attached between the lever arm and the floor at the right.

**The prony brake.** To measure the brake horsepower (B. H. P.) of any engine, an instrument known as the "prony brake" or, more technically, "the absorption dynamometer," (Fig. 284) is used. This consists of a band which may be tightened around the engine pulley, creating great friction on the pulley and requiring constant force acting to overcome this friction. As this force is acting constantly on the rim of the pulley, in one revolution of the pulley the force acts through a distance equal to the circumference of the pulley. The circumference is 3¼ times the diameter. The product of the length of the circumference and the force of friction acting will give the work done in one revolution. Then by counting the number of revolutions per minute and multiplying this number by the work done in one revolution and dividing by 33,000, we get the brake horsepower.

It is difficult to measure the force of friction directly, so that it is measured by suspending weights on the end of a long arm (Fig. 284). By the principle of the lever, the force acting at the circumference of the wheel is to the force exerted by the weights at the end of the arm as the length of the arm measured from the centre of the shaft is to the radius of the wheel or pulley. That is,

$$\frac{\text{Friction force}}{\text{Weights}} = \frac{\text{Length of arm}}{\text{Radius}}$$

and hence

$$\text{Friction force} = \frac{\text{Length of arm x weights}}{\text{Radius of Pulley.}}$$

And the horsepower, as stated above, being friction force times the circumference times the number of revolutions per minute (written R. P. M.) divided by 33,000 will give the following value for brake horsepower (B. H. P.) by substituting the value of the friction force found above:

$$\text{B. H. P.} = \frac{\text{Length of arm x weights x } 3\tfrac{1}{4} \text{ x pulley diam. x R. P. M.}}{\text{Radius of wheel x 33,000.}}$$

$$\text{equals } \frac{\text{Length of Arm x weights x } 3\tfrac{1}{4} \text{ x 2 x R. P. M.}}{33{,}000}$$

because the diameter is twice the radius and we may divide them.

If, now, we take pains to have the length of the arm measured from the engine shaft to the weights, just 3¼ feet long, the formula becomes simplified and we obtain, by dividing:

$$\text{B. H. P.} = \frac{\text{Weights x R. P. M.}}{1{,}500}.$$

The belt which creates the friction is usually made of heavy canvas, held by springs at one end, while a turnbuckle is used at the other end, in order that the belt may be tightened at will and the force of friction increased. In long-continued tests, it is frequently found necessary to throw water over the belt and pulley to keep them cool. In place of the weights, a spring balance may be used, care being taken that the turning direction of the pulley is such as to pull against the balance. With small engines, up to 10- or 12-horsepower, a balance reading to 25 pounds is large enough.

Gasoline and other oil engines for farm use are usually rated at their tested brake horsepower, but the power of steam engines, unfortunately, is not so accurately stated. The commercial power rating of steam engines is ordinarily only one half or one third of what they actually will do under test. The custom in making calculations is to assume that a steam engine of any specified rating will give the same power as a gasoline engine of twice the rating.

An engine is usually rated by the amount of work it will do continuously. This is true of all stationary steam engines. Traction steam engines, however, are given their commercial rating by manufacturers, this being usually only about a third of their actual horsepower, as shown by tests. It is obviously not satisfactory to compare traction engines rated at any given horsepower with other engines, either stationary steam or any kind of kerosene or gasoline types.

**Lubrication.** The essential points in operating a steam engine are the bearings and lubrication in general. The bearings must be kept sufficiently tight though not tight enough to cause heating. As the bearing wears, it must be taken up. Each bearing must be kept fully lubricated with the proper kind of lubricant. Any old thing will not do for the lubrication of a steam engine. The oil used for the cylinder is very heavy, as it must stand the high heats and pressures of the cylinder and steam chest. For the places requiring oil outside of the cylinder, a light oil is satisfactory, but it should be of good quality.

Owing to the pressures on some bearings and the pressure within the cylinder and steam chest, some form of device for forcing oil into these has been found necessary. Usually, some form of steam-operated oil cup is used. In the most common type, outside of a direct steam-pressure-operated force feed, the steam passes in one side of the oil, condenses, and forms a partial vacuum which permits the pressure on the other side to force oil along the lubrication pipes.

**Prices.** It is difficult to say much about prices because of the wide variation between manufacturers and between types and sizes of engines. Boilers erected will run from $10 to $15 per horsepower of engine which they serve. The engine will cost from $15 to $25 per horsepower, depending on whether high- or low-speed, whether simple or compound, and whether small or large, well-built or just fairly built. The life of good equipment should be 15 or 20 years at least.

**Starting up and stopping.** In operating a farm steam engine, the greatest care should be taken in starting up. With cold cylinders into which steam is turned, there is bound to be considerable condensation of the steam on the cylinder walls. The operator in starting, therefore, should be careful first to open the cylinder cocks, allowing any water collected to flow out. They should be kept opened as long as the engine is being warmed up. The drainage cocks on the steam chest should also be opened. Then the throttle should be opened slightly, and the engine allowed to warm up slowly before throwing the throttle wide open. If possible, both ends of the cylinder may be warmed at once. When the engine reaches full speed, close all cocks, open up the lubricating devices, and the engine is ready for work.

In stopping, reverse the operation. Close the throttle and open up the various cocks. Close the lubricators. Wipe off each working part with a bunch of waste, watching carefully for a loose nut, a worn bearing, a scored wearing surface, or other trouble. Constant vigilance and care mean the prolongation of the life of the engine and thus pay bountifully in actual cash saved.

**Steam-plant troubles.** In the above discussion the various essentials of the steam-plant operation are described. It is lack of attention to these essentials which causes trouble to develop. With most difficulties, the result is serious as regards the plant, because of the temperature and force which are handled. The only troubles likely to occur are owing to (1) loose parts or (2) improper lubrication.

Looseness of parts may be detected by ear and by careful inspection when shutting down and before starting up. It must be remedied at once, or serious smash-ups may occur.

Lubrication must be properly carried out according to the manufacturer's instructions, or the parts will heat, expand, and bind. The result is a shutdown, a wait for cooling, and thorough lubrication after inspection. If, on inspection, injury to the parts is found to exist, new parts must be provided or the old part repaired. Lack of lubrication with first-class oils and greases always ultimately costs a great deal more than proper attention in the first place.

# CHAPTER 18

# Electricity on the Farm

*By* W. K. FREUDENBERGER, *who, though an engineer by profession, has never lost touch with the farm conditions and environment amid which he was born and brought up. Until entering college he lived on a farm in Moniteau County, Mo. Since graduating from the University of Missouri, he has practised electrical engineering. For about 10 years he was in charge of the light aud power work with the U. S. Steel Corporation, the American Smelting and Refining Co., and the Colorado Fuel and Iron Co. Then, for six and a half years, he was chief engineer of the Public Service Commission of Nevada. At present he is with the similar commission of his home state. Meanwhile he has found time to complete a special course in agriculture at the University of Missouri and to manage, with marked success for 14 years, a large farm near Columbia.*—EDITOR.

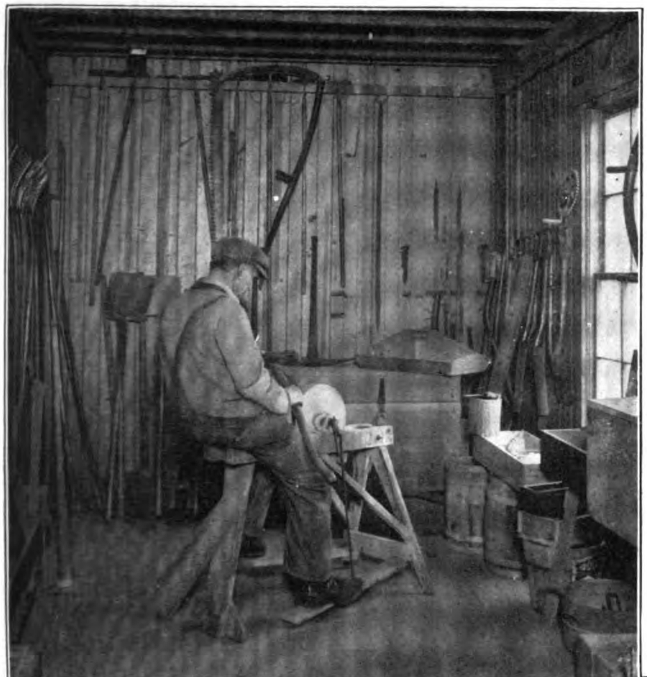
ELECTRICITY is the principal source of light and power for most classes of people in this country—except farmers. However, they, also, should make more general use of electricity for these purposes, because (1) it produces a much better, safer, and more convenient light; and (2) as power for driving the numerous small machines about the house, barn, and dairy, it saves much time and hard work. Its use for cooking, ironing, and other household tasks and in the incubator and brooder, also, is very desirable.

The average farmer knows how to manage his farm and make of it a profitable business enterprise; but many farmers who are well-to-do and know how to make money do not know so well how to use it in the best way to obtain for themselves and families those conveniences, comforts, and niceties which alone make it worth while to accumulate wealth, and which make life pleasant and worth living.

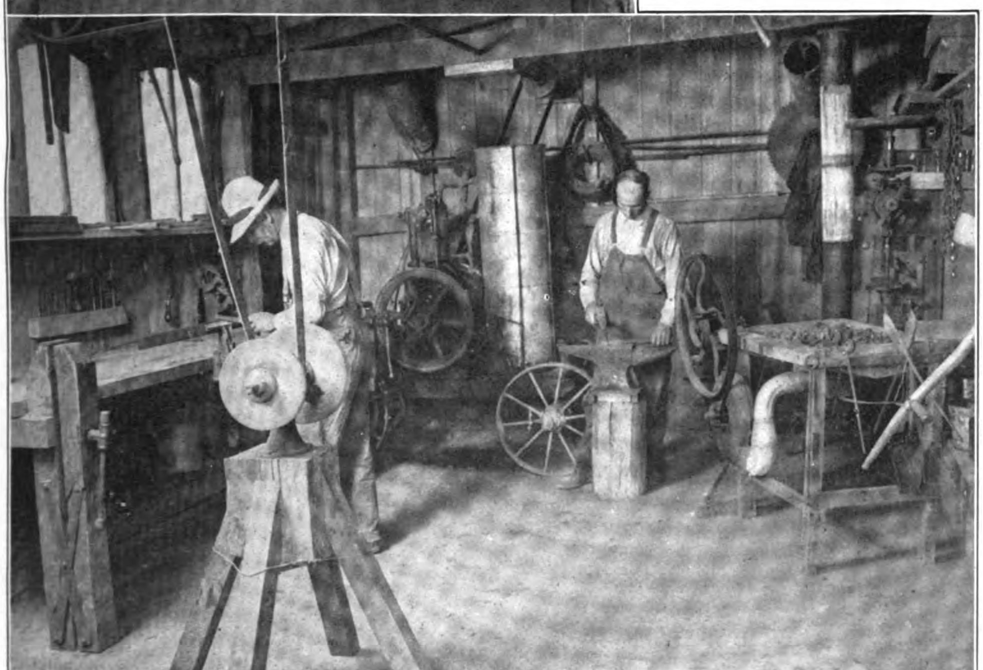
Rural life can be made more attractive than city life. In the city, the struggle for existence is incessant, and home life falls far short of life in the country with its pleasant and healthful and beautiful surroundings. Less hard labor and more recreation are needed, however, to make the average farmer's life pleasant and attractive. Nothing can bring about these results so surely as labor-saving and time-saving electric appliances. Many city people recognize the advantages of living in the country, and have country estates or country homes. They surround themselves with all the modern conveniences, however; for, without these, country life would lose some of its attractions.

**Advantages of the electric light.** Electricity produces a white, soft light which is pleasant to the eye and which enables one to do any kind of work at night almost as well as in the daytime. It is much more convenient than oil lamps, which have to be moved about, because chandeliers, brackets, or cords may be suspended from the ceiling or fixed to the wall wherever needed. Plugs, cords, and drop lights provide table and desk lamps when desired. The oil lamp requires frequent cleaning and filling, and must be lighted with a match, whereas electric globes require nothing more than an occasional dusting and a washing, at the regular house-cleaning time, and the

FIG. 285. Electricity in the home makes for health, hospitality, and happiness. The farmer is just as entitled to these as the city man.

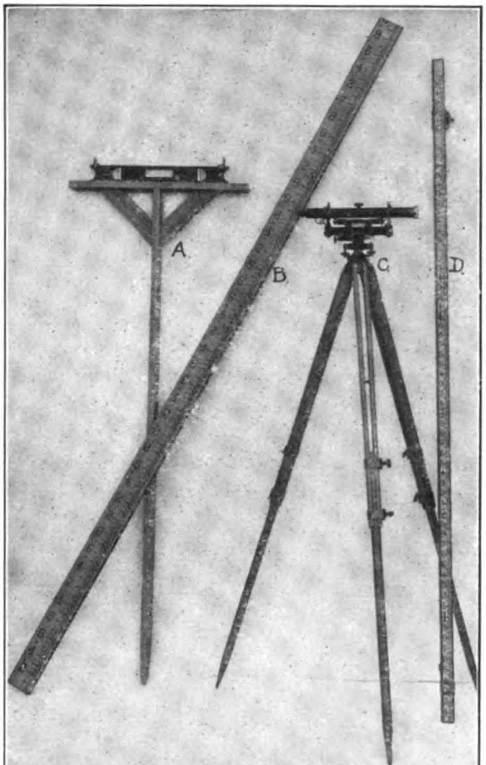


If the farmer would give his implements the care that a carpenter gives his tools, he would find their cost lessened, their life lengthened, and their usefulness greatly increased.



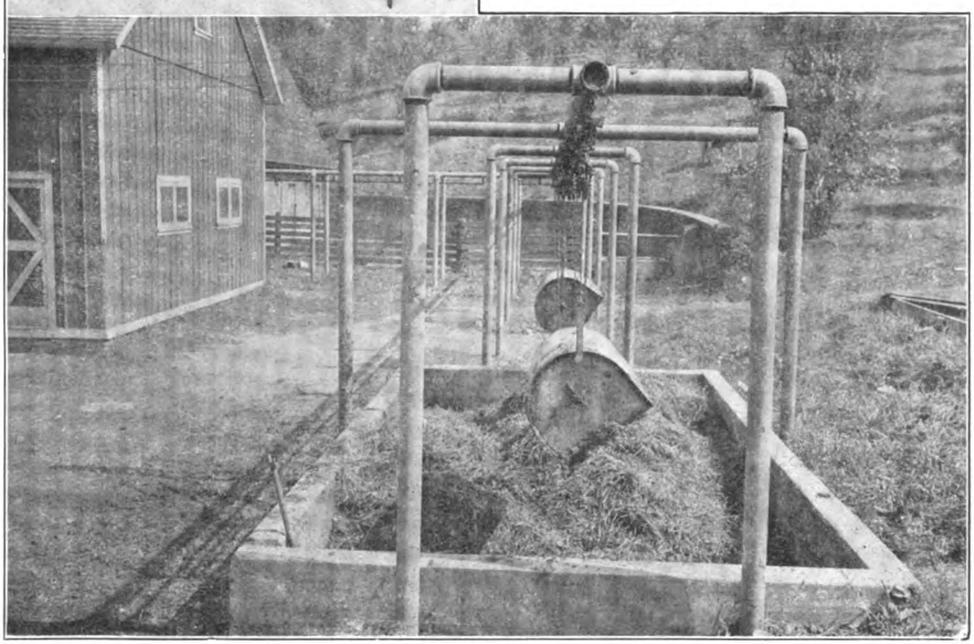
**Equipment promptly and carefully repaired loses little if anything in efficiency and saves both time and money for its owner**

**EVERY TOOL AND MACHINE THAT THE FARMER USES DESERVES SHELTER WHEN NOT IN USE, INTELLIGENT HANDLING, AND FREQUENT OVERHAULING**




These instruments, a knowledge of some fundamental principles, and a little practice are all the farmer needs for most of his engineering tasks. A, mounted carpenter's level; B, sighting rod made of a flexible tape tacked on a 1 x 4-inch board; C, engineer's level; D, self-reading rod. (See Chapter 21.)

Concrete and other modern building materials enable the farmer to do most of his construction work without outside help



**PROBABLY NO INDUSTRY, NOT PRIMARILY ENGINEERING OR MECHANICAL IN NATURE, MAKES AS MUCH USE OF THE PRINCIPLES OF THESE SCIENCES AS DOES FARMING**

light is turned on and off by simply pushing a button or turning a switch. Oil lamps give off an offensive odor, burn up the oxygen in the room, are frequently smoky and sooty, and smudge the fingers, while the electric light is clean and pleasant to use, gives off no smoke and very little heat, and does not throw off any poisonous gases.

There is still another and a most important advantage possessed by the electric light: it is perfectly safe to use and produces no flame, whereas there is always danger of explosions and fires with oil lamps and lanterns from the use of matches in lighting them, or from overturning by accident, or by stock, if at the barn.

On every general farm, there is a large amount of work to be done about the farmstead that requires much time and hard labor to accomplish, such as pumping the water for house use and for stock, grinding corn and other grain, chopping hay, turning the grindstone, running the cream separator, churning, washing and ironing, cooking meals and washing dishes, sweeping and housecleaning, and many other tasks. On account of a shortage of farm hands, increasing wages, and shorter hours of labor on the farm, it is becoming more and more necessary for most farmers to do all of their own work; and, as practically all of their time is needed in the fields during the cropping season, very little can be spared for work around the house, barn, and dairy. It is very necessary, therefore, that such work be done quickly and with little labor. These results can be accomplished with electric power.

**How electricity may help farm women.** It has been the custom of many farm women in the past to employ house servants to help with the really enormous amount of work that has to be done in and around the house, but it is now practically impossible to secure house servants on farms. Under these conditions, it becomes almost imperative that farm women use electric power to do this hard work and thus to save much time and to conserve their strength, in order that they may be able to do all the work without hired help.

How time and labor may be saved by using electricity in the home, may be demonstrated in many ways. When, for instance, an electrically-driven pump is used to supply water for house use and for stock, neither the labor nor the time of the farmer is required for this purpose to any great extent. The time used need not be more than a half hour per week. Stock can then be provided with good, clean well water instead of hot, contaminated water from muddy ponds. Water can be easily stored under sufficient pressure to provide fire protection for the farm buildings, and for the convenient use of the family in the kitchen, laundry, bath, and closet from faucets in any part of the house.

An electrically driven cream separator and churn will not only save time and labor, but no cream will be left in the milk, as is the case when the separator is operated by hand, and more butter, of better quality, will be obtained from the cream.

When a grindstone is driven by electric power, the time of one man is saved, and the work of grinding ax, sickle, or other tool is done much quicker and better.

A feed grinder, for grinding corn or other grain, may be run by electric power and the time required for hauling to town for grinding be saved; also, the cost of grinding may be much reduced.

Farm women should be provided with

Fig. 286. The washing machine, electrically driven, conserves the time, strength, and good nature of the housewife.

electric washing machines, wringers, irons, vacuum cleaners, kitchen ranges, dish washers, and other electric equipment, and be free from the drudgery of their work.

The electric washing machine with wringer attached takes away practically all of the hard work of washing clothes, makes the time required for a family wash much shorter, reduces the wear and tear on the clothes, and leaves a woman free to attend to other duties much of the time.

Electric irons are used almost as universally by townspeople as are electric lights. When once tried, they are soon found to be indispensable. In the old process of ironing, one must do the work near a hot stove, and be continually walking back and forth between stove and ironing table, changing irons; whereas, with an electric iron, a cool place may be selected in which to work, and the entire washing may be ironed without moving from one position or changing irons a single time.

By using an electric vacuum cleaner, the daily sweeping and dusting can be much better accomplished, and in one operation, without hard labor and without having to breathe into the lungs germ-laden dust. Much of this work can be accomplished at the same time that the churning is being done or the clothes are being washed when these operations are performed with electric machines. So, also, the electric dishwasher can be put to work 3 times a day, helping greatly to reduce the load on the overburdened housewife.

In addition to the foregoing illustrations of the desirability and necessity of using electricity on farms, the following important reason for its use may be advanced: Many farm boys and girls, who are now leaving good farm homes, could, it is safe to say, be kept from doing so if conditions were reasonably improved at their homes, as they might be by the use of modern electrical equipment.

## Sources of Electrical Supply

Farmers may choose between 2 principal sources of electrical supply for their farms. First, they may obtain it from the electric-service companies operating in practically every city and town in our country. Second, they may purchase small electric plants and obtain their electricity from this source. In general, it is advisable for farmers to secure their electricity from the first-mentioned source, if possible, if fairly reasonable rates can be obtained and the cost of the electric lines for carrying the electricity from the company's plant to the farms is not too great. In case electricity cannot be obtained from the electric-service companies, farmers must purchase their own plants. In that event, each may have an individual plant of his own, or a group of farmers may coöperate and purchase a plant in partnership large enough to supply them all.

It is advisable for farmers to purchase their electricity from the electric-service companies, if it can be obtained at a price no greater than it would cost to produce it on the individual farms with private plants. It must be evident to any one that it would cost much less to generate electricity in very large quantities at one central plant than it would to produce the same quantity in hundreds of small plants, because the fuel and other supplies needed could be purchased at lower prices in large quantities, and the same quantity of fuel would produce a much larger quantity of electricity in the large plant because the large plant is much more efficient.

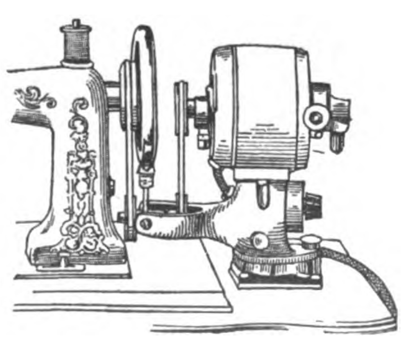


FIG. 287. The sewing machine is only one of the various household machines to which a small motor can be attached.

Furthermore, experience has shown that the capacity or size of one large plant, used to serve a large number of customers, need be only about one third the aggregate capacity required if each customer has his own plant; because they would never all be using large quantities of the electricity at the same time. Therefore the large plant would cost very much less than the group of small plants. In fact the cost of the electric-service plant together with all of the transmission lines

which are required to carry the electricity from the towns to the farms, should not cost more than the group of small plants, if the same high grade and quality of equipment is used in both cases.

FIG. 288. One way to grind an ax. Compare Fig. 288a.

As a general rule, it is possible for the electric-service companies to supply electricity at a lower cost than farmers are able to produce it on their own farms from private plants. This is the principal reason why it is advisable to purchase the supply. Another reason is that these companies have made a special study of the electrical business and thoroughly understand every detail of it. They employ experienced electricians who know how to handle the machinery, the electricity, and every part of the plant to the very best advantage. On the other hand, farmers could not be expected to handle their private plants so advantageously, they would have breakdowns and other annoyances, and their plants could not operate with such regularity and such freedom from interruptions of service as the large plants.

There are other advantages in purchasing the electrical supply. Farmers would not have to make large investments, which would be necessary if they purchased their own plants. They could get a large amount or small amount of light or power from the electric company as needed, whereas, if they generated their own supply, the plants would have to be large enough to produce the largest quantity that would ever be needed at any time.

## Electrical Terms and Expressions

In dealing with the subject of electricity it is necessary to use a number of terms and expressions the meanings of which are not generally understood. A few of the more important ones will, therefore, be defined here.

FIG. 288a. The modern, electrical way saves one man's time, the other one's back and keeps the edges keener because more easily and, therefore, oftener done.

**Electric current; ampere; ammeter.** The electricity flowing through a wire, lamp, motor or other apparatus is called an *electric current*. The *ampere* is the unit of measurement of an electric current. An *ammeter* is an instrument used for measuring the number of amperes of current flowing at any time.

**Voltage; volt; voltmeter.** The *voltage* of an electrical supply is the electrical pressure. The *volt* is the unit of measurement of voltage or pressure. A *voltmeter* is an instrument which is used to measure the voltage.

**Watt; kilowatt; horsepower.** Electric lamps and small apparatus are rated in watts, the *watt* being the unit of measurement of capacity or size. We have 15-watt lamps, 20-watt lamps, and other small sizes, also 100-watt lamps and large sizes. Large generators and transformers are rated in kilowatts. The kilowatt is usually written K. W. One *kilowatt* is equal to 1,000 watts. One *horsepower* is equal to 746 watts, or nearly three-fourths of a kilowatt. One kilowatt is slightly more than 1⅓ horsepower.

## How Electricity is Measured and Sold

Electricity is measured for sale in kilowatt-hours (usually written KWH) by a device called a watt-hour-meter or recording wattmeter. One kilowatt-

hour is 1 kilowatt working 1 hour. A 50-watt lamp uses 50 watt hours in one hour. In 20 hours, it would use 20 x 50 or 1,000 watt hours, which is 1 kilowatt hour. If the price is 10 cents per kilowatt hour, then the cost of burning such a lamp 20 hours would be 10 cents. The wattmeter measures and records with great accuracy the amount of electricity used, whether for lighting, power, or heating.

**Many farmers using electricity.** In all sections of this country large numbers of farmers are already using electric light and power, obtaining electricity from private plants or from electric-service companies. A San Francisco, California, company supplies more than 8,000 farmer customers with electricity; one at Fresno, California, more than 1,600 farmers; and there are many thousands of farms supplied by other electric companies in California, Washington, and Oregon. The greater portion of this electric demand on the Pacific Coast is for operating electric pumps for irrigation. In the central sections, especially in those states included in the Corn Belt, Wisconsin, Indiana, Illinois, Iowa, Missouri, Ohio, Pennsylvania, Nebraska, Kansas, Minnesota, and other states many thousands of farms are supplied from electric companies operating in nearby towns. Large numbers of farmers and ranchers in the Rocky Mountain states, the southern states, and the Atlantic Coast states are also using electric light and power.

**Rates and charges for electricity.** The terms and conditions under which transmission lines are built to farming sections by electric service companies, and the rates charged for the service vary widely in different places. The following examples of typical arrangements are cited as illustrations, all these being taken from the "Corn Belt":

Case 1. A company has several lines extending into the country wherever a small group of farmers who want electric service is favorably located. Ten or more farmers can usually be served from one 10-kilowat transformer and a pressure of 2,200 volts. Each farmer owns a transformer of from 1 to 2 kilowatt capacity which reduces the pressure to 110 volts for use in lamps or motors. The farmers furnish the poles and set them in the ground, and pay 10 cents per kilowatt-hour, with a minimum charge of $2 per month. This is more than city patrons served by the same company have to pay, as is usually the case, because of the extra investment in the long transmission lines and the loss of current in them and in the transformers.

Case 2. A company serves a number of farmers within a radius of 4 miles from town. The farmers paid the entire cost of the electric line, which amounted to $425 for each farm. Their average electric bill is from $4 to $6.50 a month, for which they do their washing, ironing, water pumping, cream separating, and feed grinding, and light all their houses, barns, and outbuildings.

Case 3. A company serves farmers from

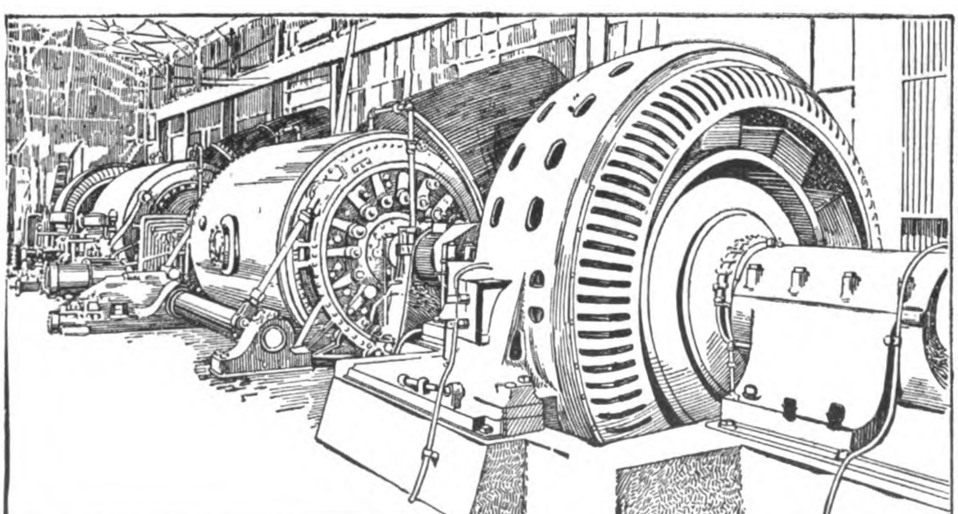


FIG. 289. The kind of power plant that is run by stream or impounded waters and that supplies electricity to farmers of certain sections at a remarkably low figure

a 2,200-volt line, furnishing the line and equipment and making a flat charge of $4 per month per farmer.

Case 4. A company serves farmers at 12 cents per kilowatt-hour with a minimum charge of $5 per month. It furnished the transmission line, but each farmer erected or paid for his own service line.

Case 5. A company serves farmers from a line which runs to a nearby town. The line is owned by the town, the farmers paying a rental of 50 cents per month each for the use of it. The company's charge for service is 12½ cents per kilowatt-hour and the average bill per farmer is about $20 a year for service plus the $6 for line rent.

Case 6. A company has 275 farmer patrons. In order to obtain service, a farmer is required to pay the company $75 for extending its lines along the public highway to his farm. The farmer builds his own service lines from the company's line on the public highway to his home. The $75 payment is later returned to the farmers in small monthly amounts, in the form of discounts on service. The rates paid are 10 cents per kilowatt-hour for the first 25 kilowatt-hours per month; 8 cents per kilowatt-hour for the next 25 kilowatt hours per month; 6 cents per kilowatt-hour for all in excess of 50 kilowatt-hours per month. A discount of 5 per cent. is allowed for prompt payment. The minimum monthly

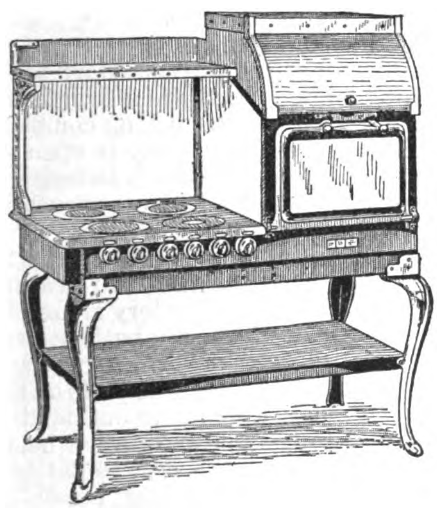


FIG. 290. An electric range, clean, efficient, cool, easily controlled and, where current is reasonable, decidedly economical.

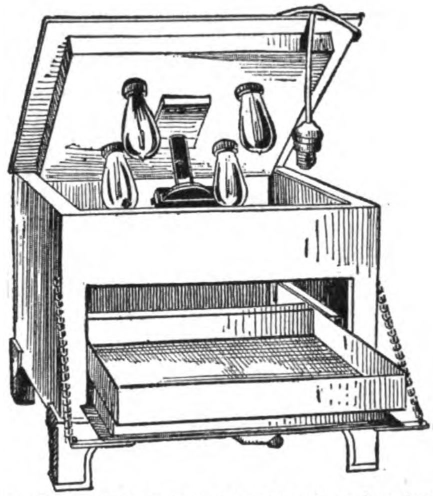


FIG. 291. The electrically heated incubator is no longer a doubtful experiment, but an established fact

charge is $1 and the average bill paid per month is from $1.50 to $1.75.

Rates on the Pacific Coast and in other sections where water power is obtainable are lower than in sections where fuel is required. The Fresno, California, company referred to above makes the following rates for farm service: 4 cents per kilowatt-hour for the first 200 kilowatt-hours per month; 2 cents per kilowatt-hour for all in excess of 200 kilowatt-hours per month. The minimum charge per month is $2.50.

There should be a more uniform system adopted for serving farmer patrons and of charging them for current and service. The service company should own and operate all lines, in the interest of uniformity, economy, and good service. A proper minimum charge should be established, and this should seldom be lower than $2 or $2.50 a month. Under some circumstances, it might be necessary to make it somewhat higher.

For the reasons given above, it is necessary for an electric company to make a higher charge for farm service than for city service either in the rate per kilowatt-hour or in the minimum charge per month, or in both.

## Coöperative and Private Electric Plants

There are, of course, many communities where it is impossible for farmers to obtain electricity from a city plant or a commercial electric light or power company. In such cases two courses are open to them: They may individually install private, individual plants, or they may form a coöperative company and install and operate a central plant to supply them all. The latter plan often provides the better service, and generally at a lower cost per farmer, thus

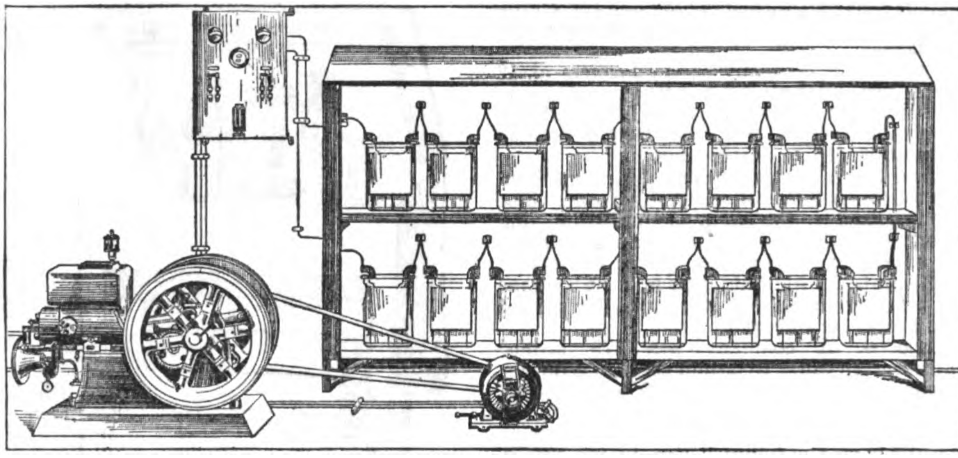


FIG. 292. A complete lighting plant for the farm house and barns. It consists of the source of power (gas engine) at left, the electricity maker or generator in foreground, the storage batteries at right, and the switchboard carrying the current gauges, etc., in rear at left.

bringing electricity within reach of many who might be able to invest a small amount in the company and pay a regular charge per year or per month when they could not afford to buy even a small individual plant outright.

A farmers' coöperative electric system could be operated somewhat on the plan of a farmers' telephone line. Under such a system, small, medium, and large farms should be able to get reasonable service at an expense not exceeding $3.50, $5, and $7.50 per month respectively, including the depreciation of the plant. The investment would be about $400, $600, and $800 respectively.

When coöperative companies cannot be formed, farmers who can afford to do so will find it highly profitable to install private plants. There are a large number of manufacturing companies which make a specialty of furnishing complete plants suitable for such use. The better-grade plants are fairly easy to operate, so that by following the instruction book furnished with each plant, a farmer will soon learn how to obtain good results, especially if he has had experience in operating a gasoline engine or an automobile.

These small plants usually consist of an electric generator, a gasoline engine to operate the generator, a switchboard with switches and electric meters to measure and control the electricity, and a storage battery. A storage battery is used in connection with farm plants for the following reason: If no storage battery were used, it would be necessary to run the engine and generator all day in order to have power or light at any time that it is needed. This would be objectionable on account of the excessive cost for gasoline, and the machinery would wear out rapidly. By using a storage battery, the engine and generator may be run for a few hours every 3 or 4 days to generate electricity and store it up in the storage battery, and then the battery is always ready to provide either electric light, power, or heat at the turn of a switch, day or night, while the engine and generator are idle.

It is very important that the manufacturers' instructions be carefully followed. The bearings of the engine and generator must be oiled at proper intervals, and the storage battery will require a little pure water occasionally as well as other attention. Solid foundations should be provided for engine and generator, to prevent vibration. The plant must be enclosed in a tight building and carefully shielded from rain. The machinery should be kept clean.

In many cases, it will be found cheaper to purchase an engine large enough

to drive the generator and some of the larger farm machines besides, such as pump, churn, washing machine, and feed grinder. The engine could be belted to a jackshaft, and the individual machines driven from this jackshaft by the use of proper pulleys and clutches. When this plan is adopted, the electric plant need not be so large nor so expensive. It would be advisable to erect a building large enough to accommodate the electric equipment and the other machines, with plenty of room so that they can all be operated conveniently.

Farmers should buy their electric plants from reliable dealers and require proper guarantees. A local dealer should be required to furnish an experienced electrician to install the machinery, put the plant in smooth running order, and give the farmer careful instructions on how to operate it and care for it.

In any case it is well to have the advice and assistance of such an expert when installing an electric system. Time is usually saved by such a procedure, and sometimes the farmer is prevented from making mistakes which might result in damage which it would cost ten times as much to repair as the services of the electrician would cost in the first place.

A good idea may be obtained of the sizes and prices of plants for farm service usually supplied by the dealers, and the amount and kind of service such plants will provide, from the data given in Table I.

TABLE I.—FARM ELECTRIC PLANTS, 30-VOLT SYSTEM
(AUTOMATICALLY REGULATED)

| SIZE OF DYNAMO IN KILOWATTS | STORAGE BATTERY AMPERE HOURS | LIST PRICE WITH SWITCHBOARD AND METERS | SIZE OF ENGINE AND LIST PRICE | LIST PRICE OF COMPLETE PLANT |
|---|---|---|---|---|
| .5 | 50 | $260 | 1½ H.P.—$ 78 | $338 |
| .5 | 90 | 310 | 1½ " — 78 | 388 |
| .7 | 90 | 360 | 1½ " — 78 | 438 |
| .7 | 180 | 455 | 1½ " — 78 | 533 |
| 1.0 | 90 | 375 | 3 " — 132 | 507 |
| 1.0 | 180 | 470 | 3 " — 132 | 602 |
| 1.5 | 90 | 550 | Direct connected sets | 550 |
| 1.5 | 180 | 645 | | 645 |

The .5-kilowatt plants are recommended by the manufacturer as being of suitable capacity for lighting a house of 6 or 8 rooms, an average-sized barn and outbuildings, and for operating electric fan, vacuum sweeper, cream separator, churn, washing machine, and other apparatus with motors not larger than one-fourth horsepower.

The .8-kilowatt plant will light a house of 8 to 10 rooms, good-sized barn and outbuildings, and operate almost all the usual electrical devices and electric machines with motors not larger than ½ horsepower.

The 1-kilowatt plant will light a home of 10 to 12 rooms, large barns and outbuildings, operate almost all the usual electrical devices and electric machines with motors not larger than 1 horsepower.

The 1.5-kilowatt plant will light a large house, very large barn and outbuildings, operate all the usual electrical devices and electric machines with motors not larger than 1½ horsepower.

**Standard voltage.** Many electric manufacturing concerns supply 30-volt plants; some of them also supply 110-volt plants. This raises the question as to which voltage is best to use.

Electric-service companies supply lighting service at 110-volts in nearly all cases, and that has become the generally accepted standard. For other purposes they usually furnish either 110-volt or 220-volt service.

Those who have private plants installed may use either the 30-or the 110-volt systems. The 110-volt plants are preferred by many for the following reasons: When the buildings to be supplied are at considerable distances from the electric plant and much current is used, the cost of wire for carrying the current is excessive when 30-volt plants are employed, which is not the case when 110-

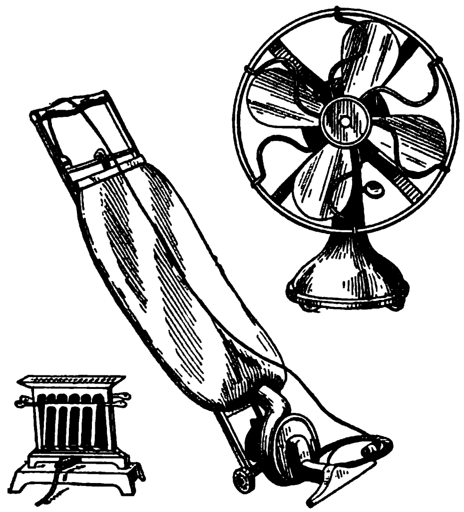


FIG. 293. Three desirable conveniences that electricity makes possible in the farm home: toaster for breakfast table, vacuum cleaner and fan.

volt plants are used. Motors and heating appliances have been standardized for 110 volts and are more readily obtainable for that voltage than for 30 volts; also they are somewhat cheaper.

The 30-volt plants are satisfactory when the electric plant is located very near the buildings to be served and large motors are not required.

In Table II, an estimate is given of the size of engine, generator, and storage battery to be used for various quantities of electricity required per month, the cost of good-quality plants of the various sizes, and what it will cost to operate them. From a study of this table, it will be seen that these plants are not so very expensive in first cost, an average-sized plant costing about $500; but if we assume that such plants will not give more than 10 years' service, and charge a proper proportion of the first cost in with the operating expense each month, the total expense will run from about $5 per month for a very small plant to about $12 for a large plant, or perhaps $8 per month for a plant of average size. This does not take into consideration interest on the plant. Almost any electric-service company within reasonable distance should be able and willing to furnish service at a much lower cost than this. This, however, is no argument against the wisdom of purchasing private plants. As before stated, if it is impossible for farmers to obtain service from electric companies, they will find it profitable and desirable to install private plants.

The engines are somewhat larger than necessary for the electric plants and they might be used to drive other machines, in addition, if desired.

**Portable storage batteries.** For those who cannot afford to install private plants, portable storage batteries will service very well to light the home. Five cells of the modern Edison battery, weighing about 100 pounds, will light a small farmhouse very well for one week on a single charge. Such a battery has a capacity of 1,395 watt-hours. It would have to be taken to a garage or to an electric plant about once a week to be recharged. Such a battery would cost about $100. It would require nearly 2 kilowatt-hours for charging each week, which should not cost more than 50 cents. Lead cell batteries of similar capacity would be heavier, but less expensive.

FIG. 294. A safe, handy electric lantern for use in unwired barns, cellars, and outdoors

**Electric lanterns and flashlights.** Electric lanterns are now being supplied by dealers similar in size and shape to the well-known railroad lantern. They are perfectly safe to use and cannot be put out by wind or rain.

TABLE II.—SIZE AND COST OF FARM PLANT AND COST OF OPERATION FOR VARIOUS QUANTITIES OF ELECTRICITY REQUIRED PER MONTH
(30-VOLT SYSTEM)

| | | | | |
|---|---|---|---|---|
| Kilowatt-hours per month | 10 | 20 | 30 | 50 |
| Size of engine (horsepower) | 1.5 | 1. 5 | 3 | 3 |
| Size of generator (kilowatts) | ½ | ¾ | 1 | 1½ |
| Size of storage battery (ampere hours) | 50 | 90 | 90 | 180 |
| Cost of plant installed | $365 | $465 | $535 | $675 |
| Operating expense per month | $1.95 | $3.00 | $4.40 | $ 7.00 |
| Depreciation per month | $3.05 | $3.87 | $3.62 | $ 5.62 |
| Total expense per month | $5.00 | $6.87 | $8.02 | $12.65 |
| Cost per kilowatt-hour | $ .50 | $ .34 | $ .27 | $ .25 |

They never get sooty, hence seldom need cleaning. They are lighted by simply moving a contact lever, thus doing away with the trouble and danger of lighting with matches. Two sizes are made, one with a 1¼-candle-power lamp and one with a 2-candle-power lamp. A battery for the small size costs about 45 cents and will operate continuously for 10 or 15 hours; one for the large size, operating for the same period costs 75 cents. If these lanterns are used for operating an average of 15 or 20 minutes a day, the cost of batteries would be about 35 cents per month for the small size, and 55 cents for the larger.

Large flashlights of the usual tubular shape are also supplied with 2-candle-power lamps. These have strong reflectors and produce a bright light. Batteries for these flashlights cost about the same per month for similar use as do those for the large-sized lanterns. The dimensions of the flashlight are: diameter 1¼ inches, length 13 inches, and the cost is $4. Various smaller sizes are also made.

## The Various Uses of Electricity

**Electric lighting.** Tungsten lamps are now used almost exclusively for lighting all kinds of buildings. Carbon-filament lamps, so popular for many years, have gone out of use because they require about 3 times as much electricity to produce a certain amount of light as do the tungsten. After-the-war list prices for the usual sizes of tungsten lamps are given below in Table III.

TABLE III.—TUNGSTEN LAMPS

| | SIZE IN WATTS. | SPHERICAL CANDLE POWER | LIST PRICE CENTS |
|---|---|---|---|
| 110-VOLT LAMPS | 10 | 6. | 35 |
| | 15 | 10. | 35 |
| | 25 | 17.7 | 35 |
| | 40 | 30. | 35 |
| | 50 | 38. | 35 |
| | 60 | 45.8 | 40 |
| | 100 | 80. | 85 |
| 30-VOLT LAMPS | 5 | 3.4 | 35 |
| | 10 | 7.3 | 35 |
| | 20 | 15.5 | 35 |
| | 40 | 32.2 | 35 |
| | 50 | 58.8 | 70 |
| | 75 | 93.7 | 80 |
| | 100 | 133.3 | $1.20 |

**Size of lamps required.** In the early days of electric lighting, 16-candle-power lamps were used quite generally for lighting an average-sized room. At the present time, 40-watt lamps, giving 38 candle power or more are the most popular. For a room 14 by 16 feet, 50-watt, 60-watt, or 100-watt lamps are more satisfactory. Two or more lamps of smaller size may be used instead of one large one, and better results obtained in many cases. Small lights may be used in closets, hallways or porches, and in outhouses and barns. Table IV gives the size of lamps generally used for different rooms under various conditions.

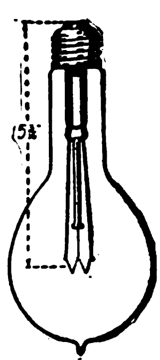


FIG. 295. Improved types of incandescent lamps for farm lighting: 100-watt (*left*), 50-watt (*right*) with sizes indicated.

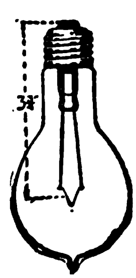


TABLE IV.—SIZES OF LAMPS USED ON VARIOUS FARMSTEADS

| LOCATION | FARMSTEAD | | |
|---|---|---|---|
| | SMALL | MEDIUM | LARGE |
| Dining room | 25-watt | 40-watt | 60-watt |
| Living room | 50-watt | 60-watt | 100-watt |
| Kitchen . . | 25-watt | 40-watt | 60-watt |
| Front hall . | ....... | 25-watt | 50-watt |
| Front porch. | 25-watt | 25-watt | 40-watt |
| Rear hall . | ....... | 25-watt | 40-watt |
| Bedrooms . | 25-watt | 40-watt | 60-watt |

The estimated amount of electricity required per month for lighting a farmstead, including barns and outbuildings, may be given as 5 kilowatt hours for a small farm, 10 for a medium sized one and 15 for a large one. In estimating the size of plant required it must be remembered that all the system will not be in full use at any one time. While the chores are being done, but little light will be used in the house; in the evening when more rooms are lit, the barns will be dark, and so on.

**Installation should be substantially done.** An experienced electrician should be employed to do the wiring of the house and other buildings and to install the electric fixtures.

For large, well-built farmhouses the electric wiring should be done in as neat and substantial a manner as is done in similar houses in cities. Switches should be placed in each room, for greater convenience in turning lights on and off. For the average farmhouse, however, switches for individual rooms may be omitted, and pull-sockets used instead. Pull-sockets are provided with short chains, which hang just beneath the lamps, within easy reach. A slight pull on the chain lights the lamp, and another pull turns it off. By using pull-sockets instead of switches, the cost of wiring may be very much reduced.

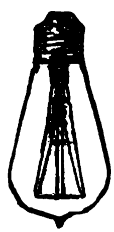


FIG. 296. 10- and 20-watt lamps are made in this style.

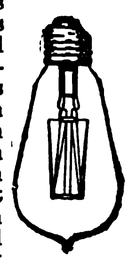


FIG. 296a. The 40-watt lamp is the size most generally used.

Generally, the lamps are suspended from the ceiling on lamp cords. They should be suspended as low as possible for best results, but not low enough to be in the way. Six feet from the floor is about the right distance. They should not always be placed over the centre of the room, but where the light is most needed, in each case.

The cost of wiring a farmhouse for lighting might be as low as $2 for each room for small one-story buildings, and 4 or 5 times as much for large, expensively-furnished houses, including cost of fixtures.

**Shades and reflectors.** There are many varieties of somewhat gaudy and highly colored lamp shades on the market. Although such varieties are frequently low in price, they are neither the most ornamental nor the most efficient. In fact, they are sometimes detrimental, rather than beneficial. The best shades and reflectors for electric lamps are those made from clear transparent glass, such as the Holophane reflectors.

**Pumping the water supply.** When it is necessary to pump from a deep well, and considerable power is required, it is sometimes advisable to locate the electric plant near the well, so that one engine may be used both for the plant and for pumping water. A separate motor is preferable, however, in most cases.

One very popular water supply system is that in which the water is pumped into an elevated tank where it is under sufficient pressure to provide flowing water at faucets in any part of the house, provide water under pressure for fire protection, and supply water to tanks and troughs for stock. The water tanks should be elevated 50 or 60 feet, or somewhat higher than the buildings to be served.

The same results are obtained with another much-used system, in which a large air-tight water tank is placed in a building or underground, and the water supply pumped into it under a pressure of from 25 to 50 pounds. The air originally in the tank is compressed and acts as a pressure regulator, forcing the water out, when faucets are opened, at practically the same pressure at which it was forced in by the pump.

In either case the electric motor which drives the pump may be made to operate automatically. That is, a float is rigged to stop the motor when the tank is full; then, when the water in the tank falls to a certain point, the float starts the motor again and the tank is soon refilled. In case the pressure tank is used, a pressure apparatus performs the same duty. When these systems are used, very little time is required to look after the water supply.

A nonautomatic system is preferred by many. That is, instead of the pump motor being started by a float or pressure apparatus, it is started and stopped by hand. The latter system is simpler, somewhat cheaper, and less liable to get out of order. It is an easy matter to start the pump before sitting down to a meal, and to stop it when the meal is finished and very little time is required.

The cost of such systems is from $150 to $200 and upward, and the power required would usually be from 2 to 4 kilowatt-hours per month.

**Washing and ironing.** The proper solution of the washing and ironing problem for farm women, as for city women, is to send clothes to the steam laundry to be washed and ironed where it is done by machinery. If this method is considered too expensive, farmers should establish coöperative laundries. Failing these methods, the only remaining course is to use electric washer, wringer, and iron. Electric washers and wringers are usually run by 1 motor of about ¼ horsepower. Manufacturers of these machines claim that there is not half as much wear on clothes washed by machine as there is when rubbed on the washing board. The big incentive to buy an electric washer and a wringer, however, is the fact that it requires only 1 or 2 hours to do a family wash in this way, and all of the hard work is done away with. The electricity required is about 2 kilowatt-hours per month, and the cost of washer, wringer, and motor is from $75 to $150.

Ironing with an electric iron makes this part of the work much less disagreeable. One need not work in a stove-heated room, but may select as cool a place as can be found,

FIG. 297. The electric flat iron is especially appreciated in hot weather.

and connect the iron to the nearest lamp socket. The ironing can be done much quicker, also, because it is not necessary to stop to change irons; the iron keeps at the proper temperature so that the ironing can be done to the best advantage all the time; and there is no walking back and forth from ironing table to stove. The cost of an electric iron is from $3.50 to $7 and the electricity required to operate it is from 5 to 10 kilowatt-hours per month.

**Cream separator and churn.** A cream separator and a churn can be arranged for operation from a single motor, which may be one-sixth or one-fourth horsepower in size for the average farm. Dairy farms should have larger machines, also electric milking machines. The power required for churn and separator for an average farm would be 2 or 3 kilowatt-hours per month. By using electric power all the cream can be taken out of the milk, when the speed of the separator is properly adjusted. When the separator is turned by hand, it is impossible to regulate the speed so that all the cream will be taken out. The electric motor takes the hard work out of churning and of separating the cream, also out of milking, when electric milkers are used. Farmers having 10 or more cows to milk will find that it is economical to install electric milking machines. Those of small size will use from 3 to 10 kilowatt-hours of electricity per month.

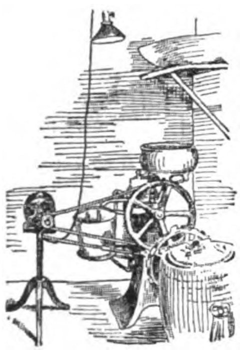


FIG. 298. Why turn the separator and churn by hand when a portable motor will do it?

**Refrigeration.** Farmers recognize the necessity of having a cool place in which to keep dairy products, fruits, and vegetables during the summer months. Many farmers build icehouses, and put up ice during the winter for use in summer. Others have no suitable bodies of water within a reasonable distance from which to obtain ice, or cannot afford to build icehouses. In any case, a small farm refrigerating plant will provide the low temperature required for preserving farm products as cheaply as can be done by storing winter ice for the purpose. For example, a test was made with a small outfit in 1915, in central Illinois during the month of July, in which a refrigerator box 16 x 36 x 50 inches was used. The power required to operate the refrigerator was less than ¼ horsepower. The motor was run an average of 5¼ hours a day for the 31 days. The temperature of the refrigerator box was kept between 40 and 45 degrees F. In the 31 days, only 36.2 kilowatt-hours were used, which, at 10 cents per kilowatt-hour, would cost $3.62. Of course, the cost of ammonia which is necessary for the refrigerating machine, and of oil for lubrication, would add materially to the total cost. But it would only be necessary to operate the machine from 4 to 5 months of a year, depending on the climate.

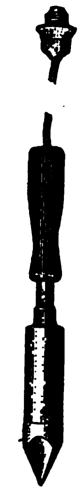


FIG. 299. Electric soldering iron.

**Feed grinder, fanning mill, corn sheller, wood saw.** A feed grinder requires considerable power, and, therefore, some farmers prefer to locate it in the building with the electric plant, so that it may be run from the same engine. If one can afford the additional investment, somewhat better results may be obtained by using an electric motor to run the feed grinder; but the other method would be quite satisfactory. A size requiring a 2-horsepower motor to drive it should be large enough for the individual farmer. It requires about 40 kilowatt-hours to grind 100 bushels of corn, but only about 8 kilowatt-hours for cracking the same amount.

The fanning mill, or seed cleaner, could be driven from the same motor that runs the feed grinder, or a portable motor should be rigged up for various uses, including the work of running a wood saw and corn sheller.

When electric power can be purchased from an electric company, such work as silo filling and threshing grain can be profitably done with electric motors; but it would not be economical to install a private plant large enough for such work, except on very large farms.

Many farmers are now buying farm trac-

FIG. 300. An important advantage of the electric washer is that it can be used in the kitchen but kept elsewhere out of the way when not needed.

tors. Such work as feed grinding, corn shelling, silo filling, threshing, sawing wood, and other heavy, intermittent work can be done with the tractor power.

**Electric range, hot plate, and toaster.** To do all of the family cooking on an electric range during the summer season would require from 100 to 200 kilowatt-hours per month. Only fairly well-to-do farmers could afford to purchase a range, which would cost from $45 to $100 and pay $5 to $10 a month for current. But farm women who have electric ranges are exceedingly fortunate and well favored. If current can be gotten from water power on the farm at very low cost they can prove economical as well as convenient.

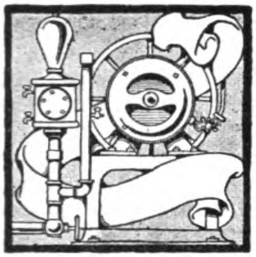
Those who must be more economical can purchase two disc hot plates and prepare two meals a day on them, using the wood range for the heaviest meal and for baking. The cost could be reduced about one half in this way.

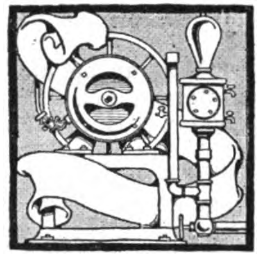
There are numerous other uses to which electricity may be put on a farm, such as house cleaning and sweeping with a vacuum sweeper, running the sewing machine with a small motor, dish washing, running ice-cream freezer, electric fan for ventilating and cooling a room, running the grindstone, heating pad, and heating the incubator and brooder.

In Table V are given a list of machines and apparatus that can be operated electrically, the size of motor generally used, and the amount of electricity required per month.

TABLE V.—SIZE OF MOTOR REQUIRED AND ELECTRICITY REQUIRED PER MONTH FOR VARIOUS MACHINES

| MACHINE | SIZE OF MOTOR | USE PER MONTH | KILOWATT-HRS. PER MONTH |
|---|---|---|---|
| Churn | $\frac{1}{6}$ to $\frac{1}{4}$ Hp | 6 to 8 hrs. | 1.0 to 1.5 |
| Cream separator | $\frac{1}{8}$ to $\frac{1}{4}$ Hp | 10 to 15 hrs. | 1.0 to 2.0 |
| Washer and wringer | $\frac{1}{6}$ to $\frac{1}{4}$ Hp | 5 to 10 hrs. | 1.0 to 2.0 |
| Milking machine | $\frac{1}{2}$ to 2 Hp | 30 to 60 hrs. | 2.0 to 10.0 |
| Water supply pump | $\frac{1}{4}$ to 2 Hp | 10 to 20 hrs. | 2.0 to 8.0 |
| Vacuum cleaner | $\frac{1}{6}$ to $\frac{1}{4}$ Hp | 30 to 40 hrs. | 3.0 to 8.0 |
| Refrigerator | $\frac{1}{4}$ to $\frac{1}{2}$ Hp | 90 to 180 hrs. | 20.0 to 50.0 |
| Range | 4,000 watts | | 75.0 to 150.0 |
| Iron | 500 watts | 8 to 15 hrs. | 3.0 to 7.5 |
| Sewing machine | $\frac{1}{30}$ Hp | | |
| Buffer and grinder | $\frac{1}{80}$ Hp | | |
| Dish washer | $\frac{1}{8}$ to $\frac{1}{4}$ Hp | | |
| Ice-cream freezer | $\frac{1}{8}$ Hp | | |
| Electric fan | 45 watts | | |
| Toaster | 500 watts | | |
| Feed grinder | 2 to 3 Hp | | |
| Grindstone | $\frac{1}{6}$ to $\frac{1}{4}$ Hp | | |





CHAPTER 19

# Internal-Combustion Engines

*By* PROFESSOR R. P. CLARKSON *(see Chapter 14). With the greatly increased use of the automobile, the principle and management of the stationary gas and oil engines (which are considerably simpler) have lost most of their mystery. To-day there are probably more farmers who can talk intelligently about ignition, compression, magnetos, etc., than there are men in other lines of work not primarily connected with engines who can do the same. A full course in the subject requires considerable time, study, and experience. All this chapter attempts is to tell the novice the essential things that he should know and to remind the experienced man of some of the important details that he may already know but may have forgotten.*—EDITOR.

GASOLINE, kerosene, and crude-oil engines of every kind belong to the internal-combustion class of motors. They are primarily heat engines, just as are the steam engine and the hot-air engine; and the principle of operation does not materially differ in the various types of heat engines. In every case, there is some working substance which, through the application of heat in some manner, causes expansion and contraction in the working space of the engine and, usually, causes a piston to slide back and forth. In this way, the heat energy of the working substance is transmuted into mechanical energy and made available for doing useful work of some kind.

In the steam and hot-air engines, the heat is supplied by the combustion of fuel outside the engine, this combustion acting to heat up the working substance. In the oil and gasoline engine, there is combustion of fuel, but it takes place right in the cylinder of the engine. Engines of the former class—steam and hot-air —are thus called "external-combustion engines," because the fuel action is outside, while those of the latter class—oil and gasoline—are termed "internal-combustion engines," because the fuel action is entirely inside the engine.

**Efficiency of engines.** The theoretical study of engines has shown very clearly that only a certain amount of the heat energy which is supplied to an engine can be converted into mechanical energy. The higher the temperatures that can be reached with the working substance, the greater the efficiency which it is possible to obtain. Internal-combustion engines are so designed that the explosion temperatures are very high; and, with the explosion taking place right in the engine, there are no losses of heat in transmission. Therefore the resulting efficiency may be made very much higher than that of any steam type. In efficiency, the internal-combustion engine has reached more than 50 per cent and runs frequently as high as 40 per cent, while 15 per cent is high for a steam engine, and 20 per cent is seldom reached. The figures, of course, apply to the different engines as means for getting mechanical energy out of fuel.

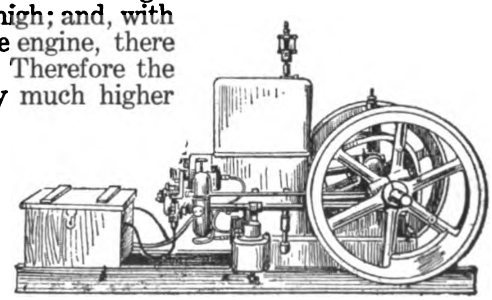


FIG. 301. Typical water-cooled, stationary gas engine with spark plug ignition system, the current being supplied by dry batteries in the box at left.

**How an engine works.** In all engines of the internal-combustion type apt to be found on the farm there are 5 main operations: (1) the fuel must enter the engine; (2) it must be compressed in one end of the cylinder; (3) it must be ignited (4) then expand against a piston, and (5) the burned gases must be got rid of by being forced out of the engine entirely. All this must be done automatically and very rapidly. In the very highest speed engine, this entire series of operations is completed 30 times in every second. In most stationary engines of small size, the speed is not more than one fifth of this; but it is fast enough to necessitate the most careful timing of every part of the action.

The fuel is stored in a tank, from which it flows by gravity to a device called a "carburetor," or "vaporizer." This is nothing more nor less than some form of atomizer in which conditions are made favorable for the vaporizing of the liquid fuel, and the thorough mixing of the vapor with air, thus forming an explosive mixture. This is drawn into the engine by the suction of the moving piston in the cylinder. The time of drawing in the charge is regulated by the inlet valves, which are operated by cams on the engine cam shaft this being geared directly to the crank shaft itself. After the mixture is drawn in, the valves are all shut, the piston comes up and compresses the mixture considerably. Then, at the proper

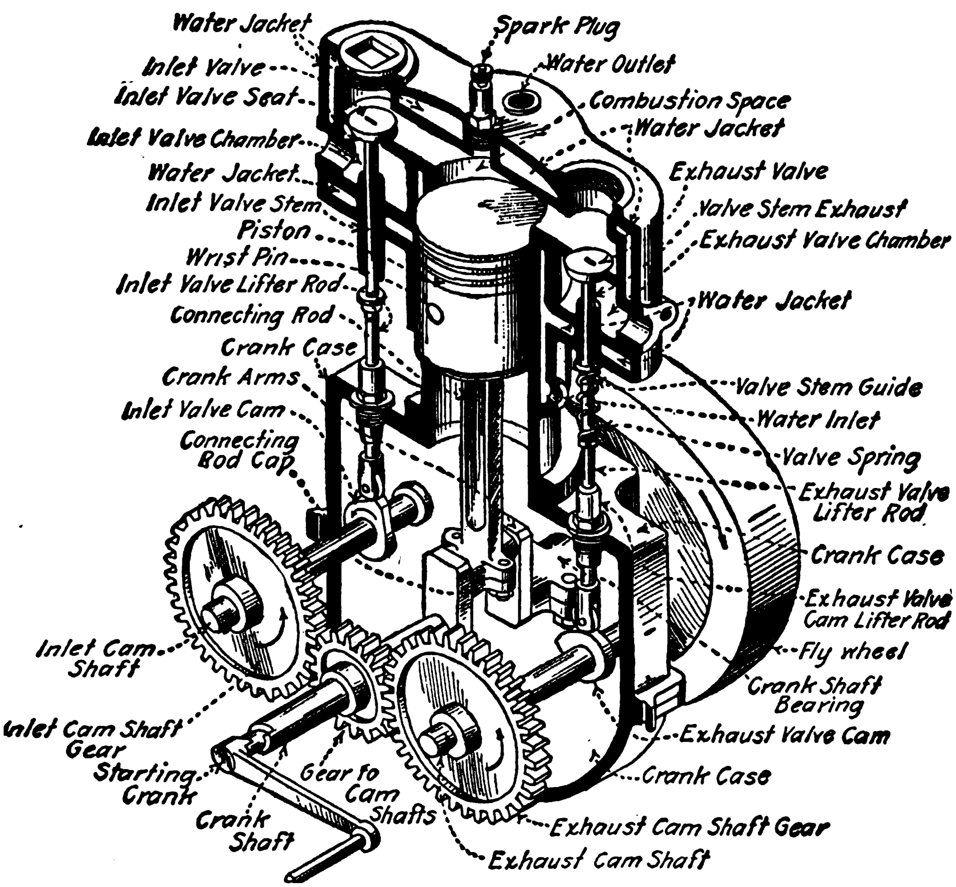



FIG. 302. Diagrammatic view of one cylinder of a gas engine with connecting parts, partly in section to show internal arrangement

moment, a spark ignites the mixture, which explodes and, by expansion due to the heat, forces the piston down again. On the return stroke, the piston drives out most of the burned gases. They are still very hot, of course, and the heat they carry away is one of the large sources of lost efficiency in oil-engine work.

### Fuels

The determination of the best fuel for economical use in small engines has occupied a great deal of thought during the past few years, because of the constantly increasing price of gasoline and the very much cheaper cost of kerosene in many parts of the country. Crude oil for engines of about 50 horsepower and over has also found strong advocates, and it is used to a considerable extent. The problem presented is very much complicated by the incidental points connected with the use of the fuels.

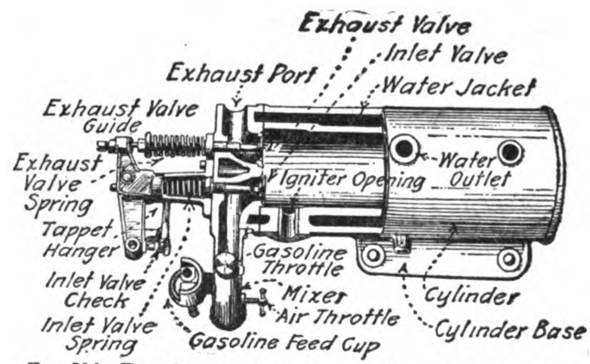



FIG. 304. Top view of a gas-engine cylinder, partly cut away to show water jacket and arrangement of valves

Kerosene is a heavier distillate than gasoline, both being obtained from crude petroleum. The crude petroleum itself is in some form used in the larger engines. Naturally, it is cheap, as there has been no material work done on it from the well to the consumer. Both kerosene and gasoline are products of "cracking" the petroleum, and are incidents in the continuous succession of products from crude petroleum. This material not only gives us our various fuel oils, but also the many mineral lubricating oils, both light and heavy—the greases, dye and munition products, and, not least valuable, the well-known vaseline, or petroleum jelly.

Theoretically, kerosene has a higher heat value than gasoline, in the proportion of 11 to 9; but it is not possible to get the full value of kerosene in a gasoline engine. A much higher temperature is required to vaporize it than gasoline, and more evaporating surface is required. Then, within the engine, combustion is not apt to be complete, so that a deposit of carbon is left on the cylinder walls, piston head, and spark plugs, thus requiring frequent cleaning. Any gasoline engine will run after a fashion on kerosene, if started and warmed up on gasoline. Some adjustment of the carburetor may be, and usually is, required. Some kerosene engines may be started by heating the ignition tube with a blow-torch, but this is not recommended for farm use.

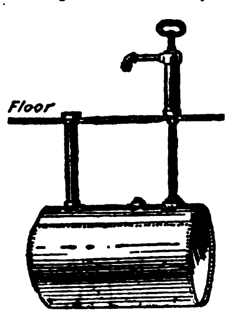



FIG. 303. Fuel for gas engines should be kept in an underground metal tank, preferably well away from all buildings, and equipped with tight supply pipe and delivery pump.

The amount of kerosene usually required is over 1¼ gallons to 1 gallon of gasoline, because of the incomplete combustion. In engines specially built to run on kerosene, trials have frequently shown an actually smaller consumption of kerosene than of gasoline in a gasoline engine doing the same amount of work in the same time. In general, the amount of fuel consumed per horsepower per day of 10 hours is about 1 gallon, sometimes more, but seldom less, even with expert attendance or supervision.

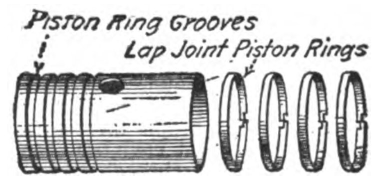



FIG. 305. A piston removed from a cylinder to show the rings which create the compression and the grooves in which they fit.

There are many good engines built to run on kerosene fuel that give more or less satisfaction. There is every reason why that type of engine should be purchased. There is an economic importance in the use of kerosene in place of gasoline as fuel; for it will tend to lower the price of gasoline by lessening the demand, and will, at the same time, leave this more refined product for special purposes in which kerosene will not serve as a satisfactory substitute. While, of course, by increasing the demand for kerosene, the tendency will be to increase the price, there is a plentiful kerosene supply due to the large production of it as a

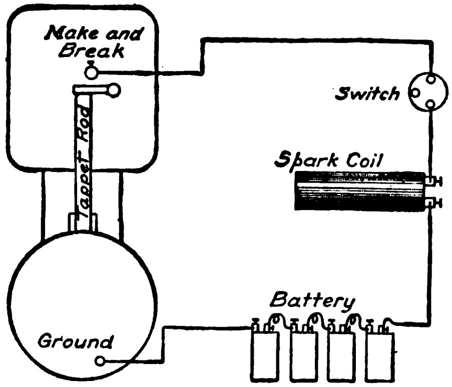



FIG. 306. Diagrammatic wiring plan of a make-and-break ignition system in which a spark coil is used. The batteries are connected in series and with the engine where the wire is grounded. The make-and-break mechanism is operated by the tappet rod and this by moving parts of the engine

by-product in refining to produce gasoline and other oils.

All these things being taken into consideration, there is no doubt as to the superiority of the kerosene engine over any other type of power plant on the farm. This is being demonstrated by the constantly decreasing use of steam and other engines in proportion to the total power used.

## Carburetors

The first action on the fuel is to prepare the explosive mixture. This is done mainly in the carburetor. The common form of carburetor has 2 chambers, one being a float chamber in which the fuel is kept at a constant level by the action of a float—either of coils, hollow brass, or aluminum—this float rising as fuel flows in and shutting off the supply at a valve when the proper level is reached. The fuel from the float chamber then flows to a second chamber, through which air is brought by the suction of the engine. This air is frequently warmed by some auxiliary connection, as by an intake situated near the exhaust pipe or manifold. The air passes through a constricted tube and thus acquires a high velocity. In the smallest part of this tube, where the velocity is highest, the rushing air passes over the surface of the fuel oil, picks up some of it, and mixes with it on the way to the cylinder.

There are many different types of carburetor, but the general action here outlined fits all of them more or less. The tendency is to effect in some way a very perfect and intimate mixture of the gas and air before they enter the cylinder. With the engines of very high speed, now in use to a large degree where light weight is essential, sufficient time is not given between explosions for complete combustion of the fuel. As explained below, this combustion is not instantaneous.

The kerosene vaporizer differs from that for gasoline in that it involves some device, usually a hot tube or hot-water jacket on the carburetor for warming the fuel and helping to atomize it. There is also a heating device on the intake manifold to vaporize the kerosene. These help on the familiar principle that liquids vaporize more readily when heated.

## Ignition System

Two thirds of the troubles encountered in gas-engine operation are due to defects in the ignition system or to lack of knowledge of proper ignition control. The ignition system is the vital part of the oil engine, and it must work properly and be controlled in the correct manner.

There are 2 divisions of ignition systems under which all designs may be properly classified: (1) the make-and-break, or low-tension, and (2) the jump spark or high-tension. These names refer to the particular method by which the spark in the cylinder is made.

**Make-and-break system.** With the make-and-break design, there are 2 contact points in the cylinder, one of which is movable and may be turned away from the other suddenly by a spring-trigger arrangement, after having been in contact for a very small interval of time. The 2 points are connected in circuit with a battery and a coil of wire wound about an iron core. When the points are separated, the momentum of the current causes it to jump the gap created between the points, thus giving the required spark. The purpose of the coil used is to increase this tendency of the current to continue to flow even after the circuit has been broken. The coil itself consists merely of a few turns of insulated copper wire wound about a soft iron core. Such an arrangement as this has been used for many years in electric gas-lighting systems, and is there known as a spark coil. It is commonly referred to in connection with gas engines as a "make-and-break coil" or "non-vibrating coil." The make-and-break system, because of the

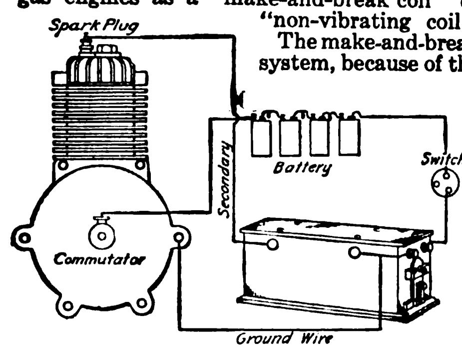
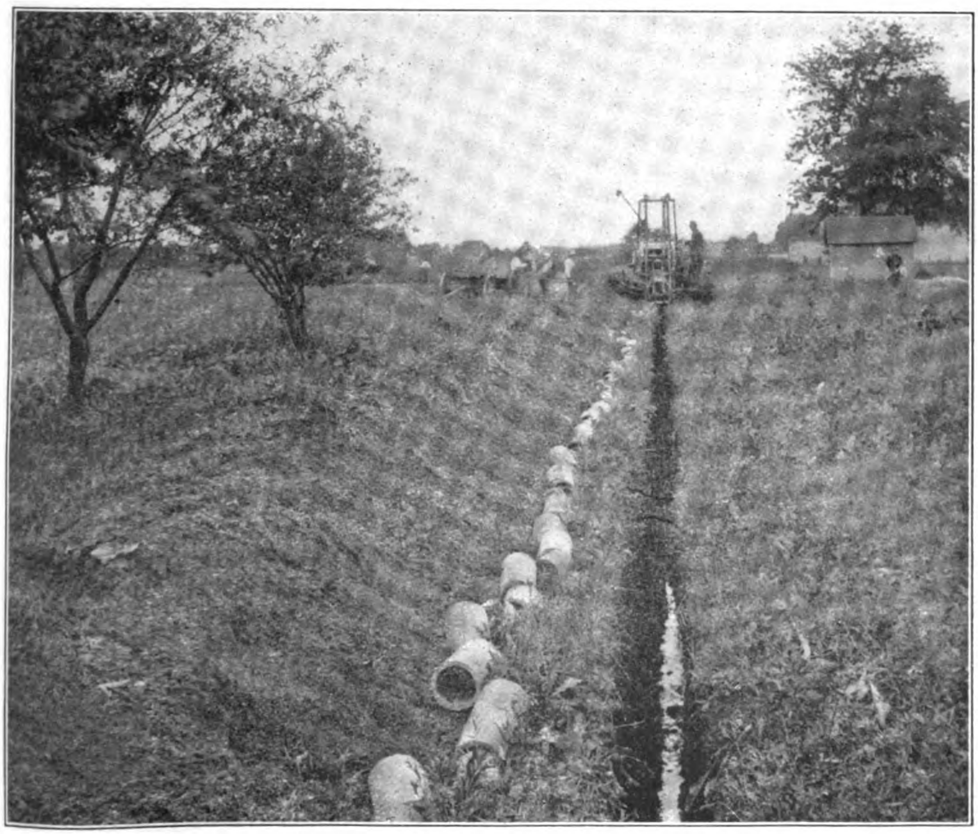



FIG. 307. Diagrammatic wiring plan for an ignition system using dry batteries, vibrating spark coil (in box) and spark plug, the timing of the spark being effected by the commutator

A piece of level bottom land on which water stands for several days after a heavy rain. One line of tile would promptly remove this surplus moisture



Whether done by hand or machine, the construction of underdrains is a cheap and simple operation as measured by its results

**DRAINAGE IS A MEANS OF RECLAIMING POOR LAND, IMPROVING GOOD LAND, AND BENEFITING THE FARM AND THE FARMER IN MANY WAYS**

Sometimes Nature provides irrigation water at the mere cost of tapping the supply. *At left*, a shallow flowing well in Colorado; *in centre*, a typical artesian well in Mississippi; *at right*, water from an underground river fork in Kansas.

**Man's task is the distribution of the water where it is needed, with the least effort and waste**

**IT WOULD SEEM AS THOUGH THE EARTH HAD PREPARED A SUPPLY OF MOISTURE IN THOSE REGIONS WHERE THE HEAVENS DENY IT. THE RESULT IS—IRRIGATION**

difficulties of mechanical design, cannot be used on high-speed engines but is used on a large proportion of stationary farm engines. It has many advantages and many disadvantages over the jump-spark system. A much hotter spark can be obtained with the make-and-break, because of a greater flow of current; there is not so much leakage of current; and the system is not so readily put out of service by dampness and dirt. On the other hand, good contacts are required all through the system, and, particularly, the contacts within the cylinder must be kept clean. This is sometimes difficult because of the presence of soot and oil. Another disadvantage is the larger number of moving parts and wearing surfaces.

**The jump-spark system.** The jump-spark design is that in which a spark plug is used in the engine cylinders. Here the spark points are stationary (but adjustable), with a fixed distance between them. They are in circuit with the secondary winding of an induction coil, commonly referred to as a "jump-spark coil," or "vibrating coil." It consists of 2 windings. The primary has a few turns of comparatively large copper wire and is connected to the battery. The secondary has many thousands of turns of fine wire, the fine wire being used solely to allow the coils to be crowded close to the core and to save space and cost. Owing to the large number of turns in the secondary, the voltage, or "pressure," of that circuit is higher than that of the battery circuit, and so it can force a flow of electricity across the gap. The current flowing in the secondary is less than that in the primary, and it cannot be measured easily and directly by convenient instruments. The current in the primary, however, may be measured by means of a pocket battery ammeter, and should not exceed one fourth or one half an ampere, if the circuit is in proper condition.

The principal disadvantage of the jump-spark design is the high tension or voltage used, because of the difficulty with which proper insulation is obtained. The least dirt or moisture is fatal to its workings. The

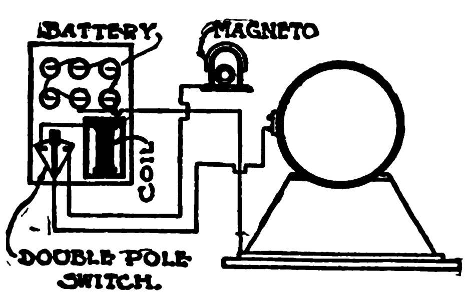



FIG. 308. Wiring plan when batteries and low tension magneto are used in a simple make-and-break system. Actually the magneto is attached, metal to metal, to the engine base so as to complete the circuit

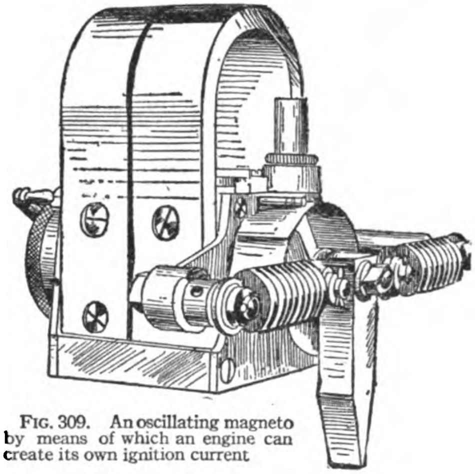


FIG. 309. An oscillating magneto by means of which an engine can create its own ignition current

vibrator in the primary circuit, used to open and close the circuit rapidly, sometimes gives trouble. This system is generally adopted for medium and small-sized engines.

**Magnetos** are common sources of electrical energy in ignition systems, being really a special type of generator or dynamo generating alternating current at either a high or a low voltage. The low-tension magneto replaces the battery in the make-and-break system and, occasionally, in the primary circuit of the jump-spark design. Frequently there is a special spark coil built in low-tension magnetos designed for automobile ignition but this is not common in farm-engine magnetos. The high-tension magneto, when used, takes the place of the whole jump-spark system, if desired, the spark plugs being connected directly to the magneto terminals.

Another type of magneto used on stationary engines is of the oscillating make-and-break type shown in Fig. 309. To use this type an engine must be equipped with a cam to work the oscillator. This is controlled by a spring which, when it is released, draws it back breaking the contacts and thereby making a spark. Often a double spring oscillating attachment is arranged with the springs set horizontally thereby giving a somewhat better balanced magneto and insuring a more even spark.

In all of these systems, the electrical action is practically instantaneous; but although combustion in the engine cylinder is extremely rapid, there is a definite lapse of time between the closing of the electrical circuit and the point of maximum pressure set up by the explosion of the gases. The exact length of this period depends upon the proportions of air and vapor in the mixture. The combustion period with a mixture of 1 part gas to 4 parts air is four hundredths of a second, and that with a mixture of 1 part gas to 14 parts air, thirty hundredths.

On this account, the spark circuit must be

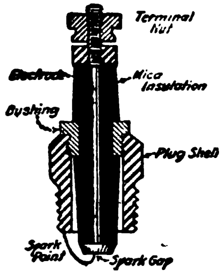



FIG. 310. Section of a spark plug. The metal thread screwing into the cylinder head makes one connection; the central electrode, joined to the spark-coil wire by means of the thumb nut, makes the other.

closed a little while before the piston gets to the exact point where it is desired that explosion shall take place. This may even be before the piston reaches the end of its compression stroke, for even so, the force of the explosion does not occur until after the maximum compression has taken place and the piston started back.

The richness of the mixture varies from time to time, and so, of course, there must be changes in the point of ignition. This variation in the mixture is due to changing the throttle, opening and closing it from time to time as the load varies. Then, too, with an increase in the speed of the engine, the spark must be advanced, because the circuit must be closed earlier in the stroke, to allow the same period of time to elapse before the piston reaches the end of stroke, the piston traveling so much faster than before. On the other hand, if the engine is being started, the piston is traveling slowly, and so the spark must be retarded. That is, the circuit must be closed when the piston is at the end of the compression stroke, or after it has passed the end of stroke usually the latter. In either case, the maximum force of the explosion will occur after the piston has started back. Care should be taken that explosion shall not occur when the piston is exactly at the end of the stroke, because that causes bad knocking, owing to the full force of explosion being transmitted directly to the crank and crankshaft bearings.

If explosion occurs before the piston reaches the end of the compression stroke, when the engine is being started, it may turn the crank forcibly in the reverse direction and so injure the operator who is trying to turn it the other way. If the explosion occurs too early, when the engine is running, there will be a loss of power, because the force of the explosion will oppose the motion of the piston. Then, too, combustion is slower with the gas under less pressure, so that the engine will become overheated, if run continually with a much-retarded spark.

These facts underlie 3 rules of spark control, which should be memorized and understood by every engine operator. They are:

(1) Always retard the spark before starting the engine.

(2) Always advance the spark as the engine picks up speed.

(3) Always retard the spark when the engine slows down under a heavy load.

In every case when the engine is running, the object of spark control is to secure an explosion at the moment when the crank has passed the dead centre and the piston has started back on the return stroke. This will give the maximum power and the most economical operation. An explosion at any other time in the stroke wastes fuel and injures the engine—from undue strain, if before the piston reaches the end of stroke, and from overheating, if after.

## Types and Parts of Internal-Combustion Engines

**Four-cycle engines.** The entire operation, from the intake of the mixture to the exhaust of the burned gases, is a cycle of operations. In one class of engines it takes 4 strokes of the piston, the first stroke sucking in the charge, the return stroke compressing it, the explosion forcing the piston out on the third stroke, and the piston pushing out the burnt gases on the fourth stroke. Then it is all done over again. This kind of engine is a four-stroke-cycle type, usually called a "four-cycle type." This is to distinguish it from the two-stroke-cycle engine, the details of valve construction necessary to make the two-stroke cycle possible being very different.

**Two-stroke-cycle engines.** In the two-stroke-cycle type, the explosion forces the piston out, this movement of the piston compressing the mixture in the crank case. The compressed charge flows up into the cylinder as the piston, toward the latter part of its outward stroke, uncovers an inlet port in the cylinder side. Just before the inlet port is uncovered, an outlet or exhaust opening on the opposite side of the cylinder is uncovered, so that the

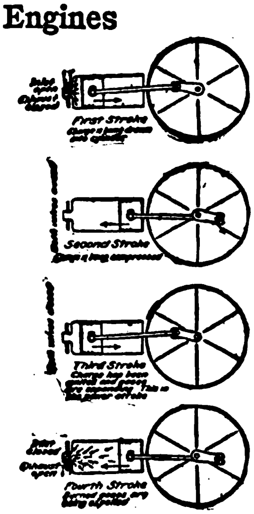



FIG. 311. Diagram showing the successive operations in the working of a 4-cycle engine.

exhaust gases start out and are helped somewhat in the scavengering process by the inflow of the new charge. This inflow is stopped as the piston returns on the instroke, the mixture is compressed, and ignition takes place, followed by the explosion.

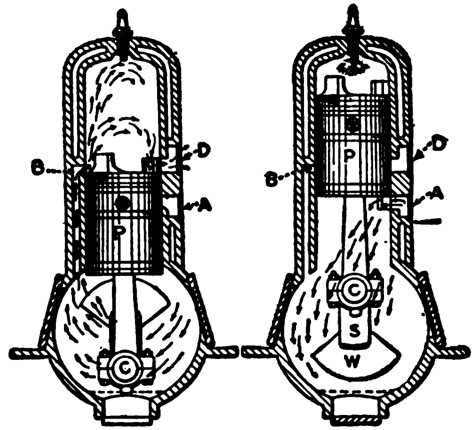


FIG. 312. How a twocycle engine works. Note that the crank case is enclosed and takes part in carrying out the series of operations.

In this case, the piston really acts like a valve, allowing both intake and exhaust at a certain fixed time in the stroke. As both inlet and exhaust ports are open at the same time, there is some mixing together of the fresh charge and the burned gases, thus cutting down the explosive force on the piston. If it were not for this fact of a weaker resulting mixture and, also, the loss of some of the fresh charge through the exhaust port, the two-cycle engine would give twice the power at the same speed as the four-cycle and with a similar weight and bulk of material. As a matter of practice, the weakening of the charge and the nature of the valve openings make the two-cycle type a slow-speed engine, and with the same size of engine only about 30 per cent. power is obtained, using perhaps slightly more fuel in proportion than with a more similarly powered four-cycle machine.

**Diesel engines.** Engines of the Diesel type (Fig. 313), more or less modified, are a modern development for farm use and have attained considerable popularity because they start and run on any of the cheap, low-grade fuels such as crude oil, fuel oil, kerosene, tops, distillate, etc. They are of the four-cycle type but require neither carburetor nor electric ignition system. On the suction stroke of the piston pure air is drawn in through the intake valve (*a*). During a part of this stroke the fuel required flows by gravity into a fuel cup (*f*) through a separate needle valve (*d*) the amount of fuel admitted being regulated by the action of the engine governor on this valve. On the compression stroke the air is compressed very highly so that it becomes extremely hot, ignites a part of the fuel in the fuel cup and the pressure created by this burning portion forces the remaining fuel oil as a spray (*h*) out of the cup and through the spray openings (*g*) into the cylinder (*k*) where it burns and creates an explosive pressure, forcing the piston (*l*) out on the expansion stroke. At the end of this stroke the exhaust valve opens and the piston traveling back on the exhaust stroke forces the burned gases out through the muffler.

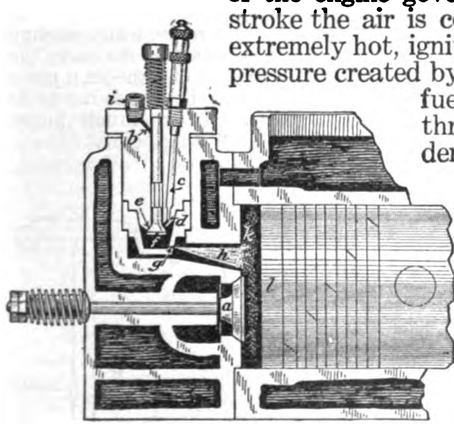


FIG 313. Section through cylinder head of Diesel type engine. *a* air intake valve; *b* fuel passage; *c* needle valve stem; *d* needle valve; *e* valve into *f*, fuel cup; *g* spray opening; *h* spray of vapor; *i* fuel supply pipe; *k* cylinder; *l* piston.

**Valves.** The important part of engine design is in the size, location, and operation of the valves. They determine to a large degree the possible speed, power, and efficiency of the engine. In the four-cycle engine they are usually operated by a series of cams on a shaft geared to the crank shaft and running at half

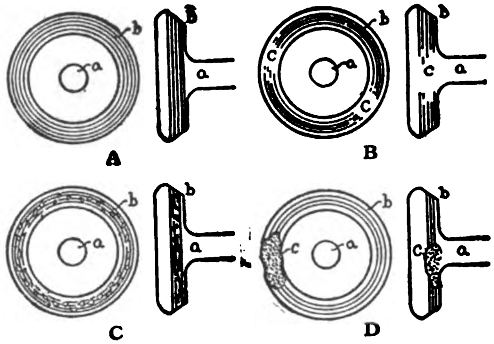



FIG. 314. End and side views of valves (*a* stem, *b* face) showing in A normal condition and, in B, C, and D various troubles. B illustrates worn spots (*c*) which cause the escape of gas; C shows a pitted surface; D shows a burned spot (*c*) which cannot be repaired, but which fortunately is not common. The other troubles can usually be corrected by grinding.

its speed. These cams open the valves at the proper points in the stroke, and coiled springs close them. When carbon accumulates in the cylinder, it is apt to be found on the valves and on the valve seats. This prevents tight closing, allows leakage, and causes loss of power. It is, therefore, a good plan to grind the valves occasionally with a fine pumice-stone paste, so that they will always seat tightly.

Governors. Many stationary oil engines have governors of one kind or another. The

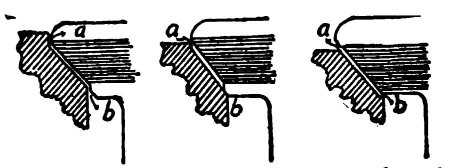


FIG. 315. One type of valve trouble comes from the wearing of the seats and valves until shoulders are formed, which prevent tight closing and therefore complete compression.

hit-or-miss type is very common. In this, the exhaust valve is held open and the inlet valve closed until the engine slows up, then the exhaust valve closes, and proper admission of gas takes place. Sometimes the governor operates so as to admit gas only once in so many strokes, depending on the speed of the machine. In all cases, the governor itself is some modification of weighted levers which are forced out by centrifugal force as the speed of rotation increases. They are like steam-engine governors in principle.

Cooling systems. Two general methods of cooling are practised—air cooling and water cooling. Occasionally, an oil-cooling method is also employed. Cooling is necessary in the interests of efficiency to increase compression, speed of explosion, and so forth, and in every way to make the temperature of explosion as high as possible. Such high temperatures as are obtained would cause expansion of all parts, increase friction, cause binding, and, in some cases, melt the metal, if it were not for some means of carrying off the surplus heat from the parts as rapidly as it is created. This, of course, causes a tremendous loss of energy, and constitutes a big problem in design. Any engine will operate better hot than cold or warm.

The air-cooled engine has flaring ribs or flanges on the outside of the cylinder casting, in order to increase the radiating surface. Air-cooled engines are lighter and usually run better than water-cooled ones. They are always small units. Water-cooled engines are more generally used, though not always the best. In this type, the cylinder has a double wall through which water circulates, from a tank or radiator, around the explosion cylinder and, in large engines, through the piston which is made hollow. Both types sometimes have auxiliary fan equipment to blow cold air over the engine, or, more often, to draw air through the radiator and increase the radiation.

The water is sometimes circulated by a small pump but more often, as a result of the change in temperature setting up currents which flow completely around the system. Occasionally, water, from some plentiful source just flows continually through the whole water jacket. The trouble most often encountered with water cooling results in the winter from forgetting to empty the radiator or tank and water jacket. Such forgetfulness frequently results in a cracked cylinder or broken pipes. Oil, alcohol and special preparations are frequently used in freezing weather to prevent this. However, as a rule it is best to drain the water-cooling system whenever it is necessary to leave the engine idle for any length of time in a place where the temperature is likely to go much below the freezing point.

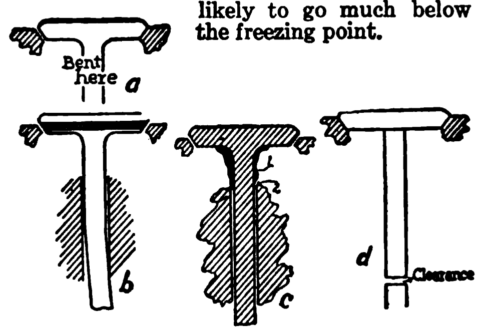



FIG. 316. Other valve troubles: *a* and *b* bent stems; *c* accumulation of carbon preventing tight closing; *d* incorrect adjustment of stem so that valve is not lifted when it should be.

## Care and Management

Cleanliness is the first essential in the proper care of engines. The cylinder, valves, ignition parts, and the machine generally should be kept free from dirt and other foreign substances. Otherwise, short circuits in the electrical system and loose parts in the machinery will result.

Oiling is another essential. All cups should be kept full and running at all times when the engine is operated. In starting, the engine should be turned over by hand to see if it is "free"; it should then be started, and the oil system put into operation at once. A high-grade oil is required for the engine cylinder where temperatures are very high, while medium or light-weight oils are used for bearings and the like. In winter, lighter oils can be used than in summer. Proper oil circulation should be insured by the use of an oil pump in the system.

The fuel oil must flow freely, and admission of air into the storage tank must always be provided for, in order to force the fuel feed. Usually, there is a tiny hole in the cover, which takes care of that point.

The water jacket must always contain water, as a few minutes' run without water cooling would be very likely to destroy the engine.

The ignition system must be kept in operating shape and given careful inspection involving the tightening of all connections, the keeping of all wires dry, the maintaining of the voltage of the battery used, and certainty that the ignition points of the spark plug or other electric igniter are clean.

Except in cases of overheating and binding parts, an engine will stop only when there is either lack of the explosive mixture or a broken electrical connection. An intermittent engine action may be due to a poor electrical connection, leaky valves, or poor mixture.

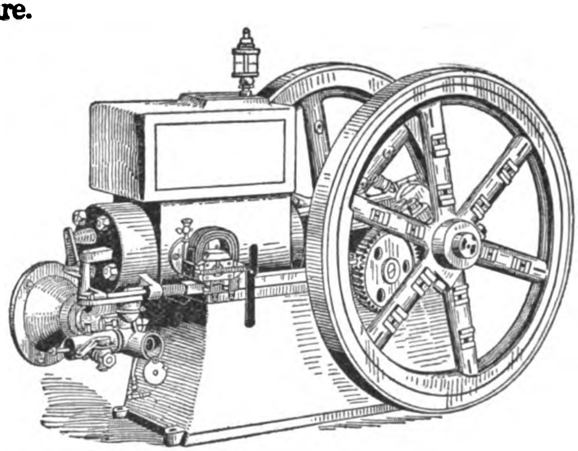


FIG. 317. Horizontal type of internal combustion engine especially adapted for farm use. Horse power may range from 1½ to 12 or more. Ignition is effected by means of oscillating magneto shown in place at the side of the cylinder

**Sources of current.** The electric current furnished to the ignition system must come from (a) dry batteries, (b) storage batteries, (c) magnetos, or (d) generators. All are perfectly good sources. In first cost and ease of handling, nothing is so good as the dry battery. While they last, dry batteries give entire satisfaction. One of the difficulties in using them is the need of electrical instruments to indicate when they require replacing. When used for starting only, they are fairly economical.

Storage batteries, while expensive in first cost, make a very cheap source of power in operation. They must be watchfully cared for, the liquid maintained at the proper specific gravity, the amount of liquid kept to a certain point, and they must be continually recharged as they run out. Some source of direct current for charging is required, and this is very seldom readily available on the farm.

Magnetos and dynamos will furnish electricity so long as motive power is applied to them. Their power is usually furnished by the engine itself, starting usually being effected by dry batteries. The difference between the magneto and the dynamo, or generator, is one of make-up and not of principle. The magneto is a whirling coil in a permanent steel magnet, while the generator is a whirling coil in an electromagnet. They are the most desirable sources of current for farm-engine purposes.

**Valve action.** The timing of valves to open and close at predetermined points in the stroke is a very difficult matter. There are 2 valves—inlet and exhaust. The inlet

valve must be opened during the early part of an outstroke. Occasionally, it is operated by the suction of the piston, but more frequently by cams. The exhaust valve opens before the end of the explosion stroke and remains open until the end of the exhaust stroke. Directions for timing and for setting are always provided for each individual engine by the manufacturer, but, when received from the factory, the engine should be properly timed. There is, therefore, rarely any necessity of timing it again unless the engine should be taken apart for cleaning and repair. In this case it would be advisable first of all to mark with a prickpunch the matching points of the various parts, so that in reassembling the engine they can be fitted together again just as they were before being taken apart.

## Judging and Buying an Engine

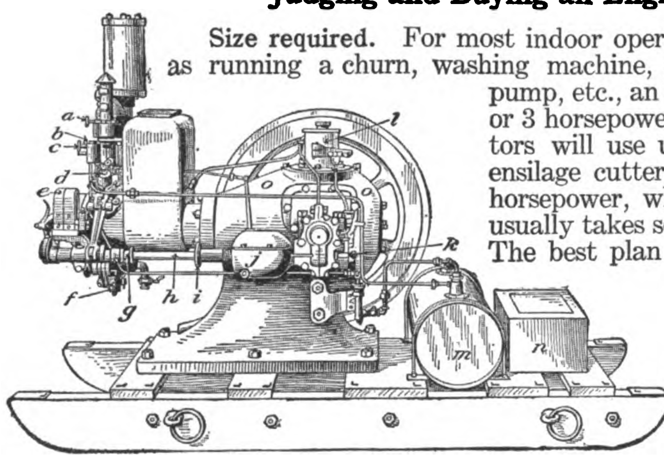


FIG. 318. Horizontal, internal combustion engine of a standard farm type mounted on skids for easy transportation about the farm. A truck may replace the skids. One fly wheel has been removed to show parts as follows: *a* gasoline valve; *b* water valve; *c* kerosene valve; *d* intake valve; *e* magneto; *f* exhaust valve; *g* compression relief cam; *h* side shaft; *i* speed changing device; *j* governor; *k* fuel pump; *l* mechanical oiler; *m* fuel tank; *n* tool box; *o* crank case (enclosed)

**Size required.** For most indoor operations on the farm, such as running a churn, washing machine, grindstone, corn sheller, pump, etc., an engine will need up to 2 or 3 horsepower. Feed mills and elevators will use up to 5 horsepower. An ensilage cutter should be from 6 to 30 horsepower, while a threshing machine usually takes somewhat more than that. The best plan where all of this work is to be done is to get 2 engines: one of, say, 4- or 5-horsepower, and the other larger and big enough to take care of the heaviest work you have to do. A heavy engine running under a small load of 2- or 3-horsepower will take as much fuel and oil as a 5-horsepower engine running at full load. The saving effected by using a small engine for light work will pay for the engine in a short time.

## Sources of Electrical Supply

**Determining the horsepower of an engine.** The use of the indicator and prony brake for finding the power of an engine has been discussed in the preceding chapter. Gasoline and oil engines are generally rated at their brake horsepower, but it is also possible to obtain a theoretical figure on the basis of the engine's dimensions. Thus the horsepower of an engine depends on its speed, the diameter of the cylinder, and the length of the stroke. Of course, the fuel and mixture have a great deal to do with it. Four-stroke-cycle engines will give power approximately in accordance with the following formula:

$$\text{Horsepower} = \frac{\text{Diam. x Diam. x Stroke x Speed}}{18{,}000}$$

The diameter of cylinder and length of stroke must be measured in inches; the speed, in revolutions per minute.

**Essential points in buying an engine.** In buying an engine, see that it is large enough for the work, yet not too large. In construction, it must be heavy enough to "stand the racket." Look to the thickness of the frame for this. The bearings must be easily accessible; any adjustments should be positive; and the

bearings themselves should be large, the thickness of metal being about one-half the shaft diameter, and the length of bearing being 2½ to 4 times the diameter of shaft. The lubrication system should be positive in its action. The general construction should be well done. Consideration should be given to the questions whether a stationary or a portable type is wanted and whether of high or of low speed. The high-speed type is very much lighter, but not so favored for farm work. The governor should be carefully looked over, to see if it is simple, satisfactory, and not likely to get out of order readily. The ignition system should be complete and well protected from the weather, the oil, and continual handling.

**Internal-combustion versus steam engines.** There are many points in favor of the oil engine, such as less chance of explosion, less complication, and less knowledge necessary to operate it. The interest on the first cost of the plant will be less, and the depreciation should be slightly less. Yet the steam engine has a number of points in its favor, the most important being that it can be overloaded. The steam pressure may be increased to the strength capacity of the boiler, and in that way the 10-horsepower engine may be made to give 25 or more horsepower for a short period, if an emergency should arise. Of course, this would mean increased coal consumption. Then, too, the exhaust steam may be used, to some extent, about the farm for all manner of purposes—heating, sterilizing, etc. In fact, it is found that exhaust steam has really greater heating value than live steam of the same temperature and pressure, probably because of the slight pulsation or throbbing from the action of the engine.

The steam boiler requires constant attendance in keeping up the fire and keeping the water level neither too high nor too low. It requires attendance in getting up steam long before it is time to start using it; and, when the engine is not used, if the fire is kept up, care must be taken of the outfit.

Against this may be put the fact that the oil engine may be started at a moment's notice and, when done with, may be shut down and no attention whatever paid to it until the next time it is needed, provided ordinary care is taken of it.

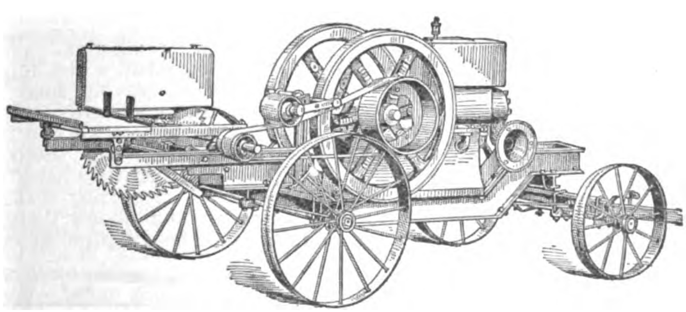


FIG. 319. Farm type of gasoline engine mounted on low metal truck to which is fitted a removable sliding-table saw rig. With this detached the engine may be used for any other kind of belt work.

## CHAPTER 20

# How to Care for Farm Implements

*By* F. H. DEMAREE *(see Chapter 8). Every farm implement should have various cost items charged against it so that the owner may know whether or not it is giving service in proportion to its value. The most important of these items are: the original cost; the interest charge for the money invested; the yearly repair cost; and the annual depreciation, which is based on the useful lifetime of the machine. An investigation in Ohio showed the average investment in machinery on a number of farms, averaging 160 acres in extent, to be $774. Another investigation gave 3 per cent as an average yearly repair cost on such machines. Adding 6 per cent interest, such a farm has a charge of nearly $70 to make against such machinery each year. If it lasts 10 years, the total cost of principal (purchase price), interest, and repairs will by that time be $1,470.60. If the average 160-acre farm has 120 acres of crops, each must be charged with its share of this cost or slightly more than $12 in the period, or $1.20 per year. If the machines last but 5 years, the cost will jump to $1.87 per acre per year. While such figures are but averages, they indicate one result—the financial one—of making implements last and keeping them in good condition. There are other results, such as easier and quicker work, better-satisfied help, horses less pulled down, etc., which, though harder to put on a cash basis, are no less important. This chapter tells how to insure these highly desirable results by giving farm machines the right kind of care.*—EDITOR.

IN ORDER to decrease the cost of his implements, the farmer must either make them last a longer time or operate them over a greater number of acres. Since the size of the farm is a fixed thing, and since it may be impossible or inadvisable to coöperate with the neighbors in the use of important tools, then the one great means of decreasing cost is to extend the life of the tools.

### Causes of Depreciation

**Normal wear.** There are a number of important factors entering into the depreciation of farm machinery of which the chief, probably, is use. That is what the implement is for, to use, but it is naturally desirable to extend the service over as long a period as possible.

In order to do this, all tools must be kept in good repair. Broken parts, dull working points, and loose connections all tend to destroy the usefulness of an implement far earlier than its normal time.

Plow shares, cultivator shovels, disc harrows, scraper blades and other portions of tools that stir the soil must be kept bright and sharp for efficient work. An extra share (lathe) should be kept on hand for each plow to be used in case of emergency, or valuable time will surely be lost.

Before putting any implement in the field after a period of idleness it should be gone over thoroughly and all bolts, bearings and connections tightened up. See that broken parts, even if minor ones and not seriously interfering with the operation of the machine, are properly repaired. One of the big advantages of a tool shed and shop on the farm lies in the fact that rainy days can be well employed in looking over and repairing the farm tools.

**Rust and weathering.** When a piece of iron rusts, small scales form on it; later these drop off leaving small pits. Rusted plow shares, moldboards, cultivator shovels and other parts that work in the soil are full of these pits. When thoroughly covered with a coat of rust they never scour properly again. Each succeeding coat of rust makes them worse and makes them require more time to take on a soil polish again.

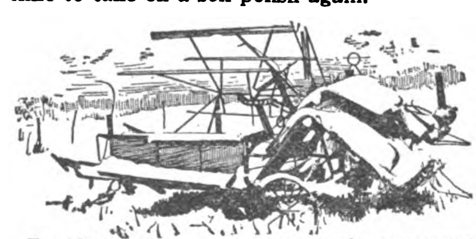


FIG. 320. Do you wear out your implements or rust them out? You wouldn't leave a piano out in the snow, yet it costs no more and is no more useful than a binder. **Why is it?**

FIG. 321. Well-cared for, nicely adjusted tools do the best work with the least effort. This plow is hitched and balanced just right or it would not steer itself.

The remedy for rust is oil or grease. Every tool that requires a polished surface for proper work should be kept well greased when idle. It is very much worth while to keep a grease rag with every plow, planter, seeder and cultivator. At night, clean the dirt away from scouring parts carefully, then smear them well with the grease rag. When one unhitches at night, he never knows but that a sudden shower will keep him from the field the next day, and maybe longer. In that case, if the scouring parts are not greased, much delay will be caused in getting them polished again.

When an implement or tool of this description is put away for the season, the scouring parts should be given a thick smear of axle grease. This will prevent the rust and, when the tools are to be used again, it will only require a few minutes to scrape off the grease and wash the scouring surface with kerosene. The tool is then ready for business.

The action of sun, wind and rain will soon cause the best of paint to blister and crack. It does not take long for unhoused implements to look old; as the paint scales from iron parts, rust scales form and fall away, the piece attacked gradually weakens until it suddenly breaks under the strain. Wooden parts may become water-soaked and start to decay after the paint peels off, or become attacked by boring insects of various sorts. All of these things shorten the life of the tool. *Good housing is the remedy.*

**Lack of adjustment.** One of the chief causes of undue strain and wear on farm tools when in operation is the lack of proper adjustment. Almost all implements of modern make have some places of adjustment. These may be for the purpose of taking up wear or of adapting the tools to different conditions. The man who pushes right ahead until the implement absolutely quits is merely inviting trouble and expense.

Every implement of importance carries with it directions from the factory. If not supplied, insist on getting such directions. The makers of farm tools prepare direction sheets with a great deal of care after testing out the tools under various working conditions.

Wherever possible, paste the direction sheet on the implement where it will not be destroyed or disfigured. If this is not possible, get a cheap letter file, and file all such sheets away alphabetically, so they can be found when needed.

When using a new implement, study it until you know how it ought to operate. Study the direction sheet carefully, then see that the various points of adjustment are kept in proper position. This is what makes an old implement *run like new.*

## Lubrication

Farm machinery is of necessity subject to much abuse. Tools that are put in the field will always be called on to work under adverse conditions that can not be much improved. For this reason manufacturers are doing much to protect bearings with proper housings and in using better grades of wear-resisting materials. It remains for the farmer to do his share in the matter of proper lubrication.

**Kinds of lubricants.** There are 3 kinds of material used for lubrication: oil, grease, and dry materials, such as graphite and mica. Of these the liquid oil, hard oil, and grease are in common use on most farms.

**The lubricant must be adapted to the machine.** Oiling a machine does not necessarily lubricate it. All wearing parts are more or less rough. It is the function of the lubricant to fill in the unevennesses of the wearing surfaces in order that they may not touch, and, at the same time, to have "body" enough to form a film with a tension great enough to keep the surfaces coated.

Light machinery with highly-finished bearing surfaces require a lighter-bodied oil, than heavier, more roughly-finished tools. A cream separator is one of the light-running machines in common use.

For heavy field tools, such as binders, mowers, rakes, planters, parts of threshing machines, etc., a medium heavy oil will give best results.

For bearings where dirt and dust are apt to accumulate badly, hard oil or grease supplied through pressure cups is most desirable. These materials not only do a good job of lubrication, but the pressure keeps the lubricant constantly working outward which, of course, pre-

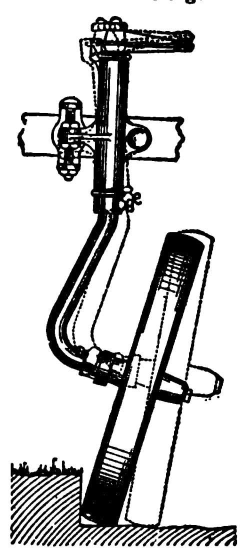


FIG. 322. Modern machinery is made adjustable to different conditions and to the effect of wear. The dotted lines show how the position of this furrow wheel of a sulky plow can be varied.

vents much dust or grit from working into the bearing.

The speed at which bearings are run is also a factor in good lubrication. A slow-speed bearing carrying a great deal of pressure requires hard oil, grease or a very thick oil with plenty of body. On the other hand, a high-speed bearing requires a thin, light-bodied oil. If a thick oil or grease is used in such bearings, the friction in the lubricant itself will be sufficient to cause the bearing to heat.

Graphite and mica are not commonly used on the farm for lubrication. Their higher cost compared with the other materials just mentioned hinders their use. A little powdered graphite dusted into bearings, however, helps smooth them up wonderfully. It will not gather dust as will hard oil or grease, so that its use should receive more consideration. A stick of ordinary lamp black can be used to advantage on drive chains of all kinds. Simply hold the stick to the chain as the machine is in operation.

## Shelter

**Need of shelter.** In discussing the subject of shelter for farm tools, the author of Bulletin 338 of the U. S. Department of Agriculture, makes the following statement: "Much has been written and said about the waste incurred by lack of housing for machinery on farms. Many large and successful farmers do not shelter their machinery at all. The principle which guides them is that, if a machine not housed at all will wear out before it is injured by exposure, there is no need to shelter it. The larger the amount of work that can be done with an implement annually, therefore, the less need there is to house it. The waste, by depreciation, of capital invested in farm machinery is caused primarily by the inability of the smaller farms to wear out their implements with profitable use. An economic remedy is partial reorganization of their business and coöperation with neighbors so that more work can be done annually with the machinery equipment."

It is true that a great many farmers seem to go on this theory, at least judging by the

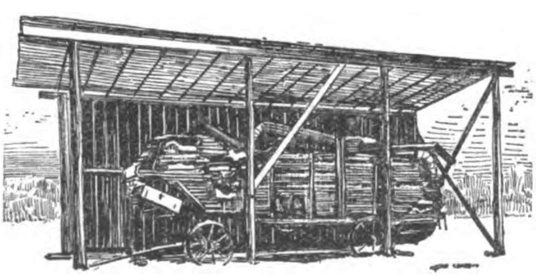


FIG. 323. Such protection as this is a little—but only a little—better than none at all. Why not go all the way?

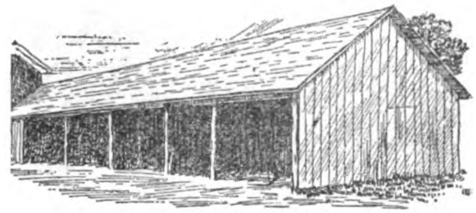


FIG. 324. A sensible, economical implement shed. It pays to make a building worthy of the equipment it shelters. This would be improved by the addition of doors.

number of unhoused implements one sees over the country. It is also true that there is no available data on the relative life of machinery when housed and when not housed. Practical observation, however, will not permit of any other conclusion than that *housed implements last longer, give less trouble and look decidedly better* than unhoused ones.

Furthermore the economic remedy suggested above fits too few cases to be effective; a farmer cannot change his land acreage at will. Moreover, the use of the various farm tools is practically universal on every farm in the community at any given time. For instance, when ground should be plowed, every farmer is at it; when corn is small, every farmer should be cultivating. Practical necessity rather than the lack of desire to coöperate has driven each farmer to maintain a rather complete line of machinery according to his system of farming.

It is very true, however, that the small farmer—the man with few acres—has a machinery investment proportionately larger than the man with more land. The small size of his business will then be a disadvantage and without working more land, his only recourse in reducing the cost of his tools is to practice as much coöperation with neighbors as circumstances will permit, and to insure *greater length of life for his tools*. As before, this means careful handling and adequate housing.

**Storage places for implements.** It is good business to reduce storage charges on farm tools as much as possible. Crib driveways and lean-to sheds are the most common places that the average farm presents for storage. It must be admitted, though, that implements so stored are nearly always in the way at one time or another, so that a machine shed on every farm is highly desirable.

**A good machine shed.** A farmer with 160 acres of land that is mostly tillable and growing corn, oats, wheat and clover will have about the following equipment: Walking plow, gang plow, drag harrow, 2 disc harrows, corrugated roller, wheat drill, corn planter, 2 cultivators, mower, side-delivery rake, hay loader, grain binder, manure spreader,

wagon and handy wagon. In normal times this equipment, when new, will have a value of about $1,000.

This machinery can all be housed in a building 24 by 36 feet. In making such a shelter, it is not necessary to have a foundation except for the posts; these supports are best made of concrete. The floor should be of earth or cinders, slightly raised above the level of surrounding land. A drain around the outside of the building is necessary to prevent water from soaking up through the floor.

For greater convenience and at little extra cost, both sides of the building can be constructed with sliding doors the entire length of the shed. The tracks should be laid so that one door will slide by the one next to it. The doors should be about 10 feet wide so as to permit driving into the shed with any implement. Where doors are on both sides they afford an opportunity to drive into the building, unhitch and drive the team out on the opposite side. This will do away with a great deal of hand pushing and lifting when storing the tools for winter.

## The Farm Shop

Some sort of farm shop, where tools or other farm equipment may be taken for all but the more complicated repairs, is indispensable to a well-organized farm. Such a farm will save both time and money in its ability to have this work done at home. If the proper equipment is at hand, many repair jobs can be done before the broken parts could be taken to town, let alone repaired there or replaced.

**Locating the shop.** If a machine shed has been built somewhat along the lines suggested, an addition 14 or 15 feet wide at one end will make an excellent shop, large enough for all ordinary purposes.

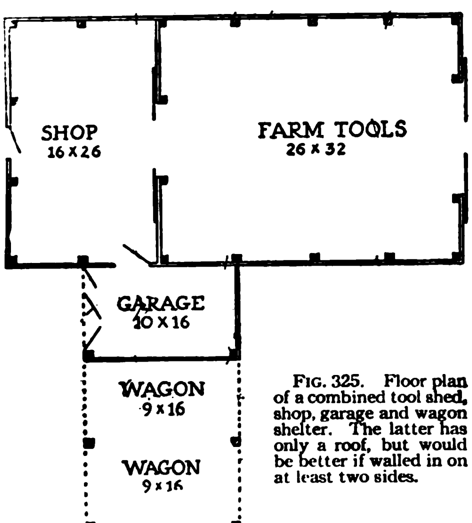



FIG. 325. Floor plan of a combined tool shed, shop, garage and wagon shelter. The latter has only a roof, but would be better if walled in on at least two sides.

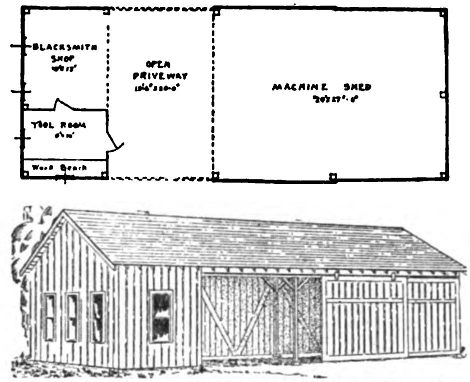



FIG. 326. Another type of shop and machine shed combined. Plenty of light and some heat are needed to make winter repair work both comfortable and efficient.

The shop should be well lighted with windows on 3 sides; if it is a part of the machine shed, a wide door should connect the two.

A concrete floor is preferable, owing to the ease with which various pieces of equipment may be bolted down securely to it. There is also the advantage of less danger from fire and the ease with which the shop may be kept clean and tidy.

The following general arrangement and equipment for a farm shop to be located in a special building has been suggested by Prof. I. W. Dickerson, formerly of the University of Illinois. Such a building should be about 18 feet square to give ample space for work. The plan is to run most of the equipment by power, but in case this is not done and some of the equipment is, therefore, not installed, the layout will still prove valuable in helping one make a plan for a good, convenient shop.

**Shop equipment.** Fairly complete equipment for carpenter work, iron work, soldering and harness repair can be bought in normal times for about $175, not including a gasoline engine. Suggested equipment for a complete shop is as follows:

*For Carpenter Work*

1 bit-stock or brace
8 auger bits, 3/16, 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, 3/4 inch
1 claw hammer, 1¼-pound
1 carpenter's square
1 try-square, 8-inch
1 marking gauge
1 ripsaw, 26-inch
1 handsaw, 26-inch
1 keyhole saw
1 jack plane, 14-inch
1 smoothing plane, 8-inch
3 firmer chisels, 1/4, 1/2, 3/4 inch
1 level, 25-inch
1 draw knife, 12-inch
1 dividers, 8-inch
1 wood rasp, 14-inch
1 screw driver, 10-inch
1 wood bench and vise
1 screw driver, 6-inch
Nails and screws

*For Iron Work*

1 blacksmith's sledge, 10-pound
1 anvil hand hammer, 3-pound
1 machinist's ball-peen hammer, 1½-pound
2 cold chisels, ½ and ¾ inch
5 punches, 1/16, 1/8, 3/16, 1/4, 3/8 inch
1 centre punch
1 adjustable hacksaw frame
1 dozen hacksaw blades
12 twist drills, 1/16, 3/32, 1/8, 5/32, 3/16, 7/32, 1/4, 5/16, 3/8, 7/16, 1/2, 5/8 inch
6 assorted files with handles
1 screw-cutting outfit consisting of two stocks and tap-wrench, and 7 sizes taps and adjustable dies, 1/4, 5/16, 3/8, 7/16, 1/2, 5/8, 3/4 inch
1 straight hardy, 1-inch
1 cold-cut, 1¾ inch
1 hot-cut, 1¾ inch
1 straight lip tongs
2 bolt tongs, ⅜ and ⅝ inch
1 forge with hand blower
1 anvil, steel-faced, 100-pound
1 iron bench and vise

*For Soldering*

1 tin snips
1 square-pointed soldering copper, 1½-pound
1 bar half-and-half solder
Large crystal sal-ammoniac
Commercially pure hydrochloric acid
Powdered rosin

*For Harness and Leather Work*

1 hand-belt punch, 4 sizes
1 hollow-drive punch
1 belt awl
1 coil belt-lace wire
1 bunch cut laces, ¼ inch
1 box copper rivets and burrs, assorted
1 lever riveting machine and box hollow steel rivets, needles, wax, thread
Iron repair stand with three lasts

*Miscellaneous Tools*

1 monkey wrench, 12-inch
1 monkey wrench, 8-inch
5 double end S wrenches
1 button wire-cutting plier, 10-inch
1 pipe-threading outfit, with pipe-stock and 6 adjustable dies for ¼, ⅜, ½, ¾, 1, 1¼-inch pipe
1 single-wheel pipe cutter
2 Stillson pipe wrenches, 10 and 14 inch
1 open-hinge pipe vise
1 pinch-point steel crowbar
1 trowel for concrete work, 10-inch
1 pointing trowel
1 sidewalk edger
1 sidewalk groover
1 putty knife
1 glass cutter
1 melting ladle for Babbitting
2½ pounds Babbit metal
Assorted paint brushes

**Machinery equipment.** Where power is desired, a 3- or 4-horsepower gasoline engine will be needed, unless electricity is available. In addition, an emery wheel, grindstone, post drill-press, main shafting, pulleys, hangers and belting will complete the equipment. In figuring sizes of pulleys, it will first be necessary to know the number of revolutions per minute the engine runs normally, then to find at what speed the various other tools should run and belt them up accordingly.

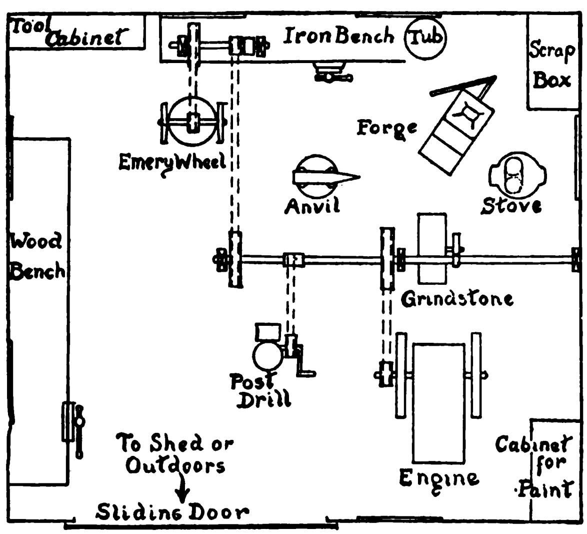



FIG. 327. A conveniently arranged and well-equipped shop in which any but the most complicated job of farm repair work could be handled. If more room were available, it would be well to leave enough clear floor space to accommodate a wagon or piece of farm machinery.

# FARM KNOWLEDGE

## PART IV

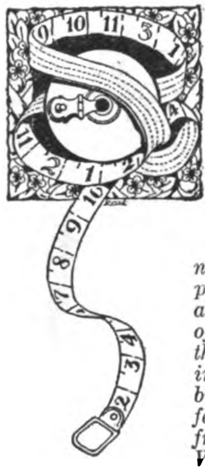
# Farm Construction and Engineering

WHEN the city man, the business man or the manufacturer has a piece of constructive work before him, whether it is the paving of a backyard, the building of a flight of stairs, the planning of a factory or the layout of a new equipment of machinery, he usually calls in a professional engineer either to advise or to take over the whole job. This expert may restrict his activities to but one branch of engineering, such as mechanical, electrical, civil or architectural, so that the completion of the task may call for several consultations and the combined services of half a dozen skilled workers.

When, on the other hand, the farmer is confronted by a correspondingly important task, he usually, almost invariably, attacks and completes it alone. This is partly because he is more or less out of reach of, or at all events out of touch with specialists in the line of work at hand. It may also be due to the fact that their number is relatively small, even though every year is seeing more technically trained engineers apply themselves to the opportunities offered in agricultural lines. In any case he solves the problem in one of two ways. Either he goes ahead with what skill his experience has given him, and by rule of thumb and the help of fortune turns out something that is more or less satisfactory and efficient; or else he seeks out what information he can, that is in usably simple form, and applies the rules and principles that he is able to make out, to the task at hand.

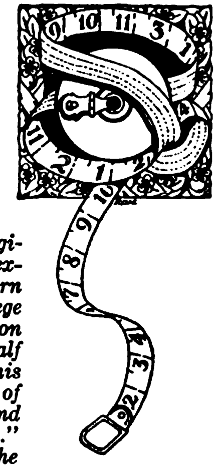
The latter is, naturally, the safer course, since the principles of any operation constitute the foundation upon which its successful practice rests. However, there has long been a lack of data and advice in these connections, sufficiently detailed and accurate to be of value, and sufficiently elementary to meet the average farmer's needs. It is with the hope of meeting these requirements that the chapters in this volume have been prepared.

Those immediately following are concerned with what may be called the Civil Engineering of the farm, or, from another point of view, farm construction and maintenance. Their applications to the handling of soils and of crops have been treated in Volume II, just as have the uses of farm machinery in their relation to soil management and crop production. The wonders that are being accomplished by means of irrigation and the millions of acres that merely await the construction of drains before becoming profitable, suggest the practical value of farm engineering operations, to mention only two of them. Moreover, in many respects, we are only at the threshold of the possibilities they offer. The farmer of the next quarter century who prepares his way with the help of the printed information that is within his reach and carries out his plans with the help of modern mechanical and scientific helps, will find his occupation not only the most useful and noble of occupations, but one of the most remarkable and inspiring as well.—EDITOR.



# CHAPTER 21

# Practical Farm Surveying



*By* E. W. LEHMANN, *Professor of Agricultural Engineering in the University of Missouri, whose practical experience began in southern Mississippi, where he was born and lived on a farm until he went to the A. & M. College of that state. Since then he has gone back and worked on the farm awhile each summer, and at present he has a half interest in a farm adjoining the old home place which his brother and he are improving. He has done all kinds of farm work "from chopping cotton to harvesting corn, and from milking to dipping the cattle for the Texas fever tick." While his actual farm experience has been gained in the South, he feels that he has the northern viewpoint. His college training brought him degrees from the Mississippi A. & M. College, the Texas A. & M. College, and the Iowa State College, and also took him for shorter courses to the University of Wisconsin and Cornell University. He taught physics 3 years at the Texas A. & M. College before taking up agricultural engineering work at the Iowa State College where for 3 more years he taught a practical course in farm surveying and drainage as well as courses in farm sanitation, machinery, and concrete construction. While in Iowa he looked after several drainage problems. In 1916 he left to take charge of the agricultural engineering work at the Missouri University. Since taking the position he has supervised some tile drainage work in that section.*

*The reader will find it of interest and value to refer to this chapter in connection with the article on Farm Arithmetic in Chapter 18 of Volume IV.*—EDITOR.

**MEASURING and mapping land.** Surveying is the operation of determining the dimension, position, volume, or area of any part of the earth's surface. A survey includes maps as well as data and notes obtained in the field, such as the description and location of points, corners, and monuments. Every farm has its engineering problems, many of which are classed as problems for a surveyor. The great need, however, is not so much for more surveyors as for more farmers with the ability to do their own surveying. The farmer as a surveyor should be able (1) to measure accurately the area of his fields; (2) to subdivide them into equal parts, if need be; (3) to locate corners, roads, buildings, fences, and tile drains; (4) to make maps including these objects; (5) to lay out tile drains, roads, and terraces, and (6) to establish the proper grades for the men to work by in constructing them.

The present system of farm management (Volume IV, Chapters 1 and 2) makes it necessary that the farmer should know the exact acreage of each field and the area occupied by each crop, so as to be able to estimate the amount each piece of land should produce. He should know the space occupied by each road, fence, and ditch, and the location of each line of tile. He should know the distance between his buildings and have them arranged so that the work of doing the chores is reduced to a minimum.

## Instruments Used in Surveying

The equipment used in farm surveying work need not consist of high-priced instruments. Quite often the work at hand can be done by means of inexpensive instruments and simple devices that can be constructed on the farm, a few of which will be discussed below in connection with the regular surveying equipment.

**The chain** and tape are used in measuring horizontal distances. Land surveys were originally made almost entirely by means of the Gunter's chain, which was often referred to in deeds, conveying property from one party to another. This chain is 66 feet long divided into 100 links of 7.92 inches each. The reason it is such a convenient length for measuring areas is that one square chain is equal to one-tenth of an acre. The objections to the chain are that (1) it is heavy and (2) the wear at the link ends will tend to make it inaccurate.

*Survey of Field with Steel Tape*

| | | | | | |
|---|---|---|---|---|---|
| AB | 482 | | | | |
| BC | 472 | | | | |
| CD | 279 | | | | |
| DE | 282 | | | | |
| EA | 272 | | | | |
| EB | 553 | | | | |
| BD | 337.6 | | | | |

*Head Chainman* *John Smith*
*Rear Chainman* *Henry Brown*
*September 3, 1917.*

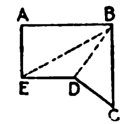



FIG. 328. Part of two pages of a notebook showing how to record data in measuring a field with a tape

*Table of Linear Measure Using Gunter's Chain*

| | | |
|---|---|---|
| 7.92 | inches (in. or ″) | make 1 link (li) |
| 100 | links | make 1 chain (ch) |
| 80 | chains | make 1 mile (mi) |

*Equivalent Table*

| Mile | Chains | Links | Inches |
|---|---|---|---|
| 1 | 80 | 8,000 | 63,360 |
| | 1 | 100 | 792 |
| | | 1 | 7.92 |

*Table of Surface Measure With Gunter's Chain*

| | |
|---|---|
| 625 square links (sq. li.) | make 1 square rod (sq. rd.) |
| 16 square rods | make 1 square chain (sq. ch.) |
| 10 square chains | make 1 acre. |
| 640 acres | make 1 square mile or 1 section |

*Equivalent Table*

| Acre | Square Chains | Square Rods | Square Links |
|---|---|---|---|
| 1 | 10 | 160 | 100,000 |
| | 1 | 16 | 10,000 |
| | | 1 | 625 |

*Table of Linear Measure (in feet)*

| | | |
|---|---|---|
| 12 | inches (in. or ″) | make 1 foot (ft. or ′) |
| 3 | feet | make 1 yard (yd.) |
| 5½ | yards or 16½ feet | make 1 rod (rd.) |
| 320 | rods | make 1 mile (mi.) |

*Equivalent Table*

| Mile | Rods | Yards | Feet | Inches |
|---|---|---|---|---|
| 1 | 320 | 1,760 | 5,280 | 63,360 |
| | 1 | 5½ | 16½ | 198 |
| | | 1 | 3 | 36 |
| | | | 1 | 12 |

*Table of Surface Measure*

| | |
|---|---|
| 144 square inches (sq. in.) | make 1 square foot (sq. ft.) |
| 9 square feet (sq. ft.) | make 1 square yard (sq. yd.) |
| 30¼ square yards | make 1 square rod (sq. rd.) |
| 160 square rods | make 1 acre. |

*Equivalent Table*

| Acre | Sq. rods | Sq. yards | Sq. feet | Sq. inches |
|---|---|---|---|---|
| 1 | 160 | 4,840 | 43,560 | 6,272,640 |
| | 1 | 30¼ | 272¼ | 39,209 |
| | | 1 | 9 | 1,296 |
| | | | 1 | 144 |

**Tapes.** The tapes suitable for use in surveying work are the metallic and the steel tape, the latter being used almost altogether at the present time. The metallic tape is of cloth reinforced with brass wires to prevent its being stretched when in use. The steel tape is the more accurate. It is marked either by etching or by stamping, and is graduated into feet and inches or feet and tenths of a foot.

The usual width of steel tapes is either one fourth or five sixths of an inch. They can be obtained in almost any length, the 50- and 100-foot lengths being the most common. They are arranged to be carried in metal and leather cases or on a reel. In many cases 100-foot lengths and even greater ones are carried in coils which can be easily wound with a little practice.

The tape has a more permanent length than the chain, because of its lack of wearing surfaces. It is light and its smoothness makes it easily handled. The fact that it is light is sometimes a disadvantage when the wind blows.

**Marking or chaining pins.** Chaining pins made of stout steel wire are used in marking, temporarily, the end of the tape or chain while measuring. Eleven pins make a complete set, and are carried on a ring made of spring steel wire with a catch. A set of pins can be easily made of No. 6 wire by any blacksmith.

**Range or flag poles.** Range or flag poles are used in establishing a line in surveying or locating a fence. They are usually about 8 feet in length, painted with alternate foot lengths red and white so they can be easily seen at a distance. The lower end of each flag pole is shod or spiked with metal. A good flag pole can be easily made of 2 x 2 inch scantling by beveling the corners and painting it.

**How to measure with a tape or chain.** The line to be measured is first marked with range poles; the head chainman then takes the 11 pins, marks the starting point with one and leads off with the zero end of the tape and the other 10 pins toward the point to which the distance is to be measured. Just before the full length of the chain has been drawn out the rear chainman signals to the head chainman by calling "halt," "chain," or "tape." As the tape is stretched to its full length by the head chainman, he is lined up by the rear chainman who calls "stick" when the chain is properly lined and drawn taut. The front chainman then sticks a pin, being careful to place it so no error will be made, and calls "stuck." The rear chainman then pulls up the rear pin and both men move ahead and repeat the operation. This proc-

ess is repeated until the head chainman has set his tenth pin, when he calls, "out" or "tally," at which the rear chainman walks forward and gives 10 pins he has collected to the front chainman.

In the use of either tape or chain in measuring distances, care must be observed to see that the tape is kept horizontal. This caution must be kept in mind, especially when measuring on a slope. When measuring down a slope the front chainman has to use a plumb-bob to determine the point at which to stick the pin.

**Errors made.** In the use of the tape or chain the most common error is due to lack of sufficient pull on tape. For accurate results the tape should be tested between 2 points a measured distance apart to get the necessary pull. Careless plumbing and incorrect alignment are also causes of error. The effect of the wind in causing the tape to sag should be avoided. Care should be taken to observe the zero point on the tape and to take readings carefully. Errors are sometimes made by omitting whole chain lengths.

**The compass** is used to establish new lines, to determine the bearing of lines already established, and to retrace old lines which are lost. The essential parts of a magnetic compass are the line of sight, the graduated circular box, and the magnetic needle. The line of sight is attached over the N and S points on the circular box. The E and W points on the box are reversed and the north point of the needle can be easily designated from the South point. This makes it possible to make all readings direct. The compass box is attached to the tripod by a ball-and-socket-joint, and leveled by plate levels. In reading the compass, point the north end of the compass box along the line and read the north end of the needle. For example, when the box is pointed to the northwest, the needle still points to the magnetic north and falls in the part of the circle marked with the N and W. The reading would be N so many degrees W. Such a reading would be a magnetic reading and not true.

The difference between the magnetic north toward which all compasses point and the true north is called the *magnetic declination* or *variation*. It varies from place to place and is not constant (the same) for any one place at different times. Since the governmental surveys are based on *true north* readings it is important to know the variation when making a survey with a magnetic compass.

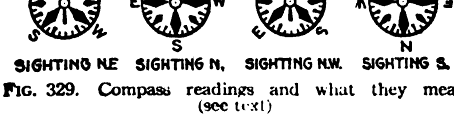



FIG. 329. Compass readings and what they mean (see text)

There are positions on the earth's surface where the magnetic variation from the true north is zero, that is, the magnetic readings and the true north readings are the same. Such a line extends across the United States, beginning in Michigan and passing to the south through the Carolinas. At all points west of this line the compass shows a variation toward the east; at all points east of the line it has a variation toward the west. This variation is as much as 20 degrees in the extreme eastern and western parts of the United States. In all government surveys, the variation at the time of the survey is recorded, so it is an easy matter to determine this value when new surveys are made.

**Care in using the compass.** The magnetic needle is a fine, hardened piece of steel, carefully balanced, hung on a delicate pivot. Both are protected by a device which lifts the needle from the pivot when not in use. This must be done each time the compass is moved from one position to another. Care must also be observed when taking a reading to see that the needle is not affected by local attraction. If too near a wire fence or a pile of old iron, or if the instrument man carries a heavy bunch of keys, the reading may be incorrect.

**The plumb line** is the simplest and most universally used of all surveying instruments. The finest transit requires a plumb line so that it may be located over a given point. For farm work the difference in elevation between points fairly close together can be determined by means of a combination of plumb line and carpenter's steel square. For short distances the grade for drains, roads, and terraces can be established with this instrument. Another device for leveling work where the plumb line is used (Fig. 330) is nothing more than an A-frame constructed of 1 x 4-inch lumber with 1 x 2-inch braces of light, well-seasoned wood. An instrument made to span 12½ feet is a convenient size. The legs should be cut 9 feet 2 inches long and nailed together at right angles at the top of instrument. They are then spread until they measure exactly 12½ feet, when the crossbar is nailed fast so it will be exactly 3½ feet from the ground. The plumb line is suspended from the top of the A-frame and allowed to swing freely until it comes to rest. The crossbar is marked where the line crosses it. The A-frame is now turned end for end on the same support and the bar again marked where it was crossed by the line. The point midway between these 2 marks is distinctly marked and called zero. When the instrument is in use and the plumb line falls on zero, the points at which the legs of the instrument rest are on a level line. If a grade is to be established and the fall is to be 1 inch in 12½ feet, a 1-inch block is put under one of the legs when in level position and a mark made on the crossbar. This instrument cannot be used to advan-

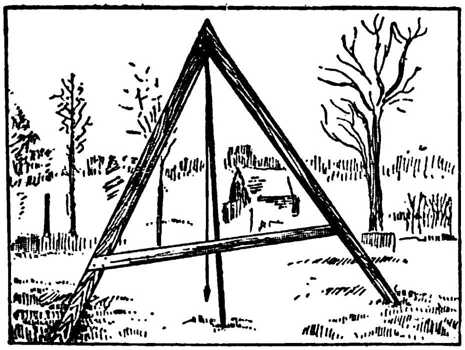


FIG. 330. A-frame carrying plumb-bob and line, a simple but efficient leveling device for the farmer

tage when the wind is blowing. If a carpenter's level is available, the A-frame with plumb-bob should not be used.

**Bubble tube.** The bubble tube is an essential part of all surveying instruments. By means of it the level, compass, and transit can be adjusted so that the line of sight will be in a definite direction or plane exactly at right angles to the plumb, or vertical line. The bubble tube is a curved glass tube partially filled with alcohol or ether. The sensitiveness of the bubble depends on the curvature of the tube. The carpenter's level is made by attaching a level tube to a block or frame and adjusting it so the bubble will remain in the same position when the level is reversed on a perfectly level surface. A point on the tube is then marked to indicate its position when the instrument is level.

**The carpenter's level for surveying.** While the carpenter's level is used almost altogether for leveling buildings and in construction work, it can also be used to advantage in farm leveling, the same method being observed as when using an engineer's level. Figure 331 illustrates carpenter's level mounted and with sights attached. Readings with the carpenter's level must be made over comparatively short distances. An A-frame, as discussed under plumb line (p. 224), with a carpenter's level attached to the crossbar makes a very serviceable farm level. In making this instrument take care to have the horizontal bar to which the level is attached a definite distance above the bottom of the A-frame. To use this in establishing a definite grade, one leg is shortened a little with a saw or the other is lengthened by means of a block of wood nailed under it. To make a fall of 1 foot to the 100 feet, a block 1½ inches thick would be placed under one leg of an instrument spanning 12½ feet, since 8 "steps" with such a frame would make 100 feet. Where this kind of an instrument is used for laying out terraces, the terrace is marked off by walking the instrument around the hill. In working from the outlet the short leg is kept in front and moved up and down the hill until the instrument is level. It is then carried forward and the back leg is placed where the front leg rested. Every few steps the points where the legs rested should be marked with stakes.

**The engineer's or surveyor's level.** This consists of a bubble tube, a line of sight and a vertical axis. The line of sight is attached parallel to the bubble tube and at right angles to the vertical axis about which they revolve. A very satisfactory farm level can be secured at a cost of about $20. The uses of such a level on a farm are many, including: (1) cross-section work to determine the necessary excavation in ditching and road building; (2) determining the difference in elevation between 2 points, as in finding the total fall in a stream to see if a hydraulic ram can be installed; (3) establishing grades for drains, roads, terraces, feeding floors, and walks, etc. To make it possible to take readings at some distance, a telescope is provided for a line of sight. Cross-hairs are set in the telescope to be used as sights.

**Level rods.** Leveling rods are graduated in feet, and tenths and hundredths of a foot. For very accurate work a target is used by which the readings may be taken to one-thousandths of a foot. Rods known as speaking or self-reading rods are read direct from the instrument and are best suited for farm leveling work. A graduated tape tacked on a 1 x 4-inch board 12 feet long makes a very satisfactory rod.

**Setting up the level.** In setting up the level the work at hand will to a great extent determine its location. Always select a point from which readings can be taken for equal distances in both directions. Set up on firm ground if possible with plates about level. Spread the tripod enough to make it solid, placing 2 tripod shoes or feet parallel to the general line of levels. Level the instrument up by bringing the telescope directly above one set of foot screws. When one of the foot or leveling screws is tightened the other must be released to prevent it binding; thus they must be turned in opposite directions at the same time to keep them to a snug

FIG. 331. Carpenter's level mounted on a standard and equipped with sights, as used in simple surveying. Inset shows the bubble tube (enlarged and with the curve somewhat exaggerated).

bearing. When turning these screws, the bubble will always go in the direction of the movement of the *left thumb*. When the bubble indicates that the instrument is level over one set of screws, revolve the telescope to stand over the other set and make the same adjustment. Continue this process until the instrument is level in whatever direction it is pointed. An instrument may be perfectly level, but it will not give accurate results if out of adjustment. The bubble tube and the line of sight must be parallel and perpendicular to the vertical axis. The instructions for testing and making adjustment which accompany each instrument are better than any general statement that can be made here.

To take readings, focus the telescope so that the rod can be seen clearly and adjust the eye-piece to see the cross-hairs. Be sure that the rod is vertical and that the bubble is in the centre of the tube before taking a reading. The telescope must be readjusted for readings when the rod is taken farther away or brought nearer the instrument. Do not disturb the tripod after the instrument has been properly set up and adjusted.

**The water level** (Fig. 332) consists of 2 glass tubes fastened upright 3 feet or more apart to a board and connected by a pipe or piece of rubber tubing. The whole thing is fastened to a staff or tripod for use. Water is poured into one tube until it can be readily seen in both. Since water seeks its level, the height of the water in the 2 tubes will give 2 points in a line of sight for leveling work. If a small quantity of ink is added to the water, the line of sight will be more readily seen. Corks should be put in the tubes when the instrument is being moved about the field.

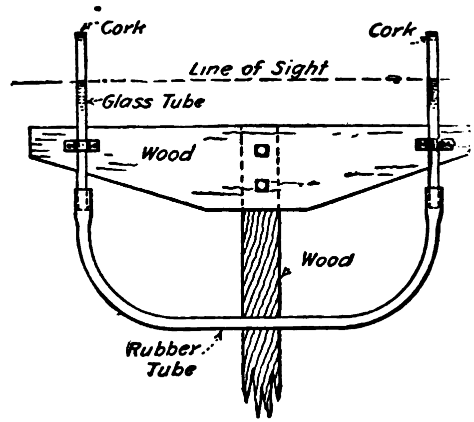



FIG. 332. How a home-made water level is constructed. When in use the corks are of course removed from the tubes.

**Transit.** The complete transit has been called the universal instrument because it can be used for so many purposes. It differs from the plain transit in that it is equipped with a vertical arc, and has a bubble tube attached to its telescope. It is adapted to the same uses as the compass and level, and measures horizontal angles with great accuracy; but, in addition, it can be used in determining vertical angles and distances, and in numerous other ways which need not be mentioned here. It requires a great deal of practice to become proficient in the use of the transit. It is not an instrument a farmer would be justified in buying unless he expected to undertake a great deal of reclamation work. In most cases of that sort the services of a trained engineer would be needed.

## Systems of Land Surveys

The two systems of land survey in the United States are: (1) the survey by metes and bounds, and (2) the rectangular system. The *survey by metes and bounds* was the original method of surveying land and still exists in that part of the United States that was first settled. In this system the boundary line of each tract of land is fully described. To illustrate, a certain farm is described as "comprising all land that is included within boundary line beginning at bald rock at the southwest corner of the farm running north, 45 degrees east 80 chains to the twin elms on hill, thence due east 60 chains to cedar stump, thence due south 60 chains to concrete block on road, thence, south, 45 degrees west 80 chains to cedar stake in ground 4 feet east of birch tree, thence north, 45 degrees west 84 chains to starting point, containing 852 acres more or less."

In order to simplify the making of surveys, to reduce the litigation of land, and to make locations more easily designated, Congress, in 1785, adopted a system since known as the United States Rectangular System of Public Land Surveys. The fact that the earth's surface is a sphere made it difficult to lay out its surface into rectangular areas. However, this difficulty was successfully overcome. The system has as a basis the true meridians, which are lines radiat-

ing from the north pole, and standard parallel lines running east and west, often called correction lines.

In each land district a *principal meridian* is chosen, and from this line an east and west line is run called the *base line*. Their intersection is the initial point of the survey. The townships are numbered north and south of the base line and the ranges east and west of the meridian. In each township there are 36 sections, each 1 mile square, containing 640 acres more or less. Each section in the township is numbered beginning in the northeast corner going west then east in the second row, etc., putting number 36 in the southeast corner. Each section is subdivided into halves, quarters, quarter-quarters, and even smaller units. A 40-acre farm may then be designated as being the N E ¼ of N W ¼ of Sec. 1, T. 3 N., R. 2 E. of some particular meridian. An important feature of this system of surveys is that all corners and lines established and approved by the government are unchangeable.

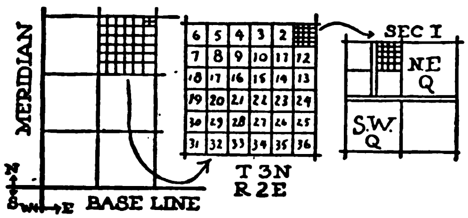



FIG. 333. The rectangular survey system showing how the ranges are divided into townships, these into 36 sections, and these again into quarters, etc. The farm described in the text is shown by the shading on the right hand figure.

The work of making a survey by metes and bounds or the reëstablishment of lines should be put in the hands of a competent engineer. It is to the farmer's interest to have permanent monuments established at all corners. Many costly lawsuits are the results of temporary monuments being placed with the idea of putting in permanent ones later. All monuments described in the sale of a piece of land acquire a perpetual and controlling significance; if recognized in a deed their position controls the location absolutely. Lost monuments can be reëstablished only by consent of parties concerned or by judgment of the court. A surveyor or engineer has no power to reëstablish a monument; he can simply act as an expert witness.

## Practical Problems for the Farmer

**Using chain or tape.** The need of erecting a line at right angles or perpendicular to another is a common everyday problem often met with in laying out fences and buildings. The simplest method is by the application of a right-angle triangle. For ordinary conditions, use 6, 8, and 10 feet as the sides of the triangle. Measure 8 feet along the line from the point A where the perpendicular is to be erected to the point B. With 6- and 10-foot chords, strike off arcs from each end of the 8-foot base A and B. The point of intersection C will give the perpendicular as the line A C. For more accurate results use a larger multiple of 6, 8, and 10 feet, as 24, 32, and 40.

**Laying out the foundation of a building.** Nearly every building is laid out with reference to some other building, road, or boundary line. If it is to be erected parallel to a road, it is necessary to establish a line on the center of the road to be used as a reference line. If there is an old fence along the roadside it would probably make a very accurate base line. Erect a perpendicular to the base line, extending it to the location of the building. In case of a square or rectangular structure, two corners are fixed on this line and the positions of the other corners determined by erecting perpendiculars at the first two corners. Each corner should be marked on a stake with a nail driven exactly at the intersection of the lines. Six or 8 feet from the corner drive 3 large stakes, and on these nail strong braces. Points on the braces are determined where the lines of the building, if continued, would cross, and at these points notches are cut, giving an easy reference in excavating.

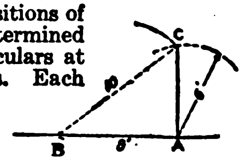



FIG. 334. How to lay off a right angle (see text).

**Laying out the orchard.** There are two general plans for laying out an orchard: the rectangular and the alternate, the latter having several variations. The rectangular system is most used; in it each tree is set at the corner of a rectangle, usually a square.

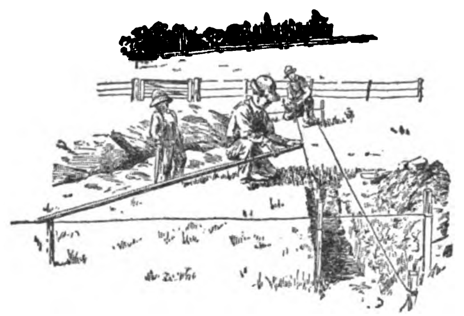


FIG. 335. The practical application of Fig. 334 in building a barn foundation

In the alternate system the trees in the even rows are placed midway or "staggered" between the trees in the odd rows.

To locate the trees in the rectangular system, lay out a base line along one side of the field at the proper distance from the fence, and lay out other lines across the ends of the field perpendicular to the base line. Set stakes along these lines at intervals equal to the distance between the trees. To locate other trees, set a range pole on the opposite side of the field at second stake on opposite end. Before measuring across toward this range pole set a pole at the third stake to measure back to when through with the second row. Before measuring the third row set a stake for the fourth, and so on. By having a pole at each end of the field the work is greatly facilitated.

A second method is by lining the trees in. A line of stakes properly spaced is established along each side of the field forming a perfect rectangle, then 2 additional rows are staked through the centre of the field at right angles to each other. With these stakes in place, the man setting out trees would have 2 stakes in each direction by which to line the trees in. The alternate system may be laid out in the same way as the rectangular.

**Surveying the farm layout.** As already mentioned, the present system of farm management necessitates a close study of the farm layout. The farm that is divided up into a great number of small fields cannot be farmed at a profit. The whole farm should be surveyed and mapped and plans developed for a future ideal arrangement. To make such a survey with a tape, if the fields are irregular in shape, it is necessary to divide them into rectangles and triangles so the areas may be easily obtained. The notes taken in the field should be complete in every detail. Sketches should be made with corners lettered, all distances tabulated, and all important points described in a well-bound field book. It is impossible to make an accurate map with a poor set of notes and sketches made in the field. In making such a survey no angles are measured, so all lines should be checked for accuracy. Extreme care must be observed in measuring over hills. To chain over a hill between 2 points not visible from each other, set a range pole at each point, then let the chainmen with range poles take positions on each side of the hill from which each can see over the hill and past the other chainman to the range pole beyond. They should then range each other in until they are on line. In measuring either up or down a slope the lower chainman should use a plumb line so the chain can always be kept horizontal. The chain is pulled taut in a horizontal position and the plumb line dropped to locate the correct position for the pin.

In chaining between two points where the view is obstructed by woods or other objects, run a trial line as near as possible toward the given point, leaving fixed points at known distances. Upon finding the error at the end of the line, correct all other points into line a proportionate amount. For example, if the random line is 1,000 feet in length and the error at the end of the line is 20 feet, then the error at the 100-foot point would be 2 feet, at the 500-foot point 10 feet, at the 750-foot point 15 feet, and so on. After points have been measured in from the random line, the desired line can be measured by these points.

To measure a line beyond a house or other obstacle there are several methods. Probably the simplest is to erect a perpendicular to the line by the triangle method, extend it out beyond the obstruction, erect another perpendicular to this line, and carry it until the obstruction is passed, then by means of two more right angles the original line can be continued.

**Mapping out the farm.** To make a neat, accurate map, a set of drawing instruments should be available. However, a usable map may be made with pencil, rule, straight-edge, and triangle. The first step in map-making is to select a suitable scale; 100 or 200 feet to the inch is usually convenient. If a 66-foot chain has been used in measuring, either 2 or 4 chains to the inch would be better. If the farm is of regular dimensions, lay out the boundary line first, then fill in details. Always remember that any point can be located by measuring from two known points. In the case of a field that is irregular in shape, one side can be mapped as a base line and other points located from it. A compass is a convenient instrument for doing this. The diagonals of all fields should be measured so they can be used in checking the corners on the map. All objects, such as drains, ditches, fences, and outbuildings should be suitably designated, and each field should be numbered and number of acres in it given on the map.

**Computing the area of fields.** To determine the area of different shaped fields, it is neces-

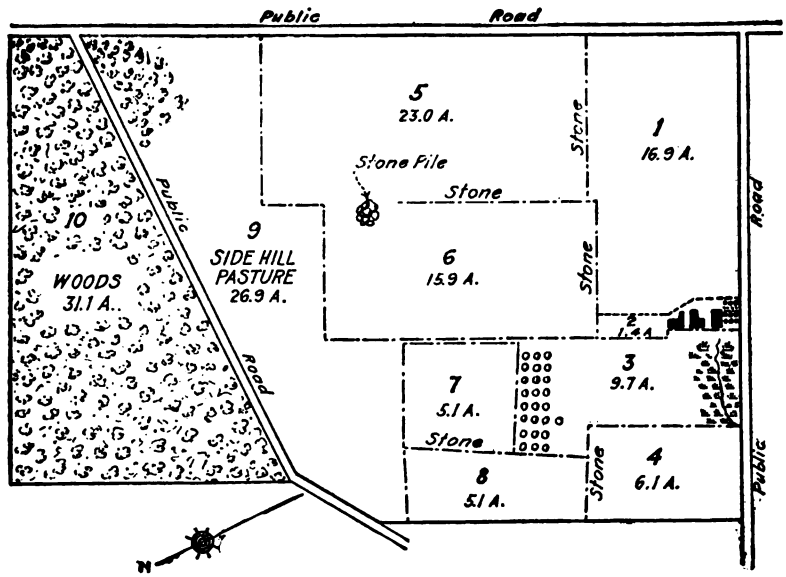



FIG. 336. Typical map of a farm, giving the most necessary facts and providing a good place on which to note plans, changes, cropping systems, etc.

sary to be familiar with the use of a few simple mathematical formula. (See also Volume IV, Chapter 18, D).

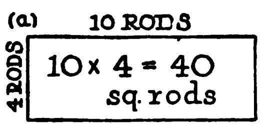



FIG. 337

*Rectangles.* The area of a rectangular field is obtained by multiplying the length times the breadth (Fig. 337)

*Triangles.* There are several methods of determining the area of a triangle: (1) If the length of one side, the base of the triangle, and the perpendicular distance from this side to the opposite angle, or height of the triangle are known, the area is equal to one half the product of the base times the height (Fig. 338). (2) If the three sides of a triangle have been measured, add the length of the three sides and divide the same by 2; from this result subtract each side in turn; multiply these three remainders and the half sum together; the square root of the product equals the area of the triangle (Fig. 339)

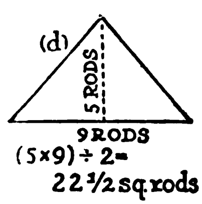



FIG. 338

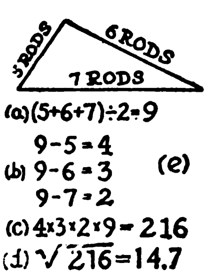



FIG. 339

*Parallelogram.* The area of a parallelogram, a 4-sided figure with opposite sides parallel, is equal to the product of one of its parallel sides and the perpendicular distance between it and the opposite side (Fig. 340).

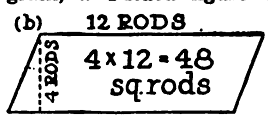



FIG. 340

*Trapezoid.* The area of a trapezoid, a 4-sided figure with two sides parallel, is equal to the product of one half the sum of the two parallel sides times the perpendicular distance between them (Fig. 341).

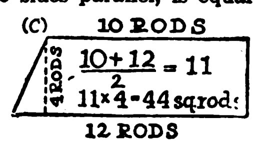



FIG. 341

Nearly all fields can be divided into suitable triangles, rectangles, and trapezoids, the areas of which can be determined. The area of a many-angled field (or regular polygon) can be found by dividing the figure into triangles by radii drawn from any point within it.

*Area of a field with a curved or irregular boundary.* In determining the area of such a field, a base line is established across the field and perpendiculars erected at intervals, thereby dividing the area of the field into a number of trapezoids, the area of which can be obtained as outlined above (Fig. 342).

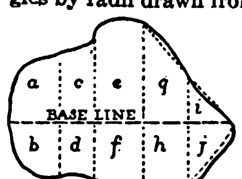



FIG. 342

## Problems in Using a Level

**To determine the difference in elevation between two points.** The simplest problem of this kind is when a reading can be taken on each point when the instrument is about midway between them. Assume that the rod reading on the first point is 10 feet, and on the second point 5 feet. These signify that the first point is 10 feet below the line of sight and the second point 5 feet below the line of sight. Hence, the diference in elevation between the two points is the difference between the two rod readings, or 5 feet. To determine the difference in elevation between two points at some distance apart the following method is followed: Set up the level and adjust it as previously outlined (p. 225) at a convenient distance for reading on the first point and in the direction of the second. As a matter of convenience assume the elevation of the starting point to be 100 feet, which we call bench mark (B M) 1. The first reading will be to determine the height of the instrument; all readings on the known or assumed elevation are for this purpose and are called back-sight (B S). The back-sight reading on B M 1 added to the elevation of B M 1 equals the height of the instrument. With the height of the instrument known, the elevation of a reference point, called a turning point, can be established nearer the point of unknown elevations by taking a fore-sight reading; a reading taken on a point of unknown elevation is always called a fore-sight (F S). Establish the turning point by driving in a stake so that the fore-sight distance will be approximately the same as the back-sight distance. The fore-sight reading subtracted from the height of the instrument equals the elevation of the turning point. The level is then moved to the second set up and a B S taken on the turning point to determine the new height of instrument. A fore-sight then establishes a new turning point and the process is continued to the end of the line. The difference in elevation between the points as found may be checked by the difference between the sum of the fore- and back-sights.

**Profile leveling.** In establishing the grade for a tile drain on a road, it is not only necessary to know the elevations of the lowest and highest points but also those of all intermediate points. The process of determining the elevation of these points is called profile leveling. The actual procedure is the same as in determining the difference in elevation between any two points except that a number of fore-sights are taken from each set-up of the instrument. Where leveling work of this character is done, it should be based on some point of permanent elevation, such as a concrete walk, a concrete floor, or a large stone. The elevation of this point is assumed and is used as a bench mark (B M) to determine the height of the instrument at the first set-up. It can also be used in checking at any future time. If such a point is not available a solid stake should be driven into the ground to be used as a reference point.

To run a line of levels for a tile drain, set the instrument up at a point where a reading can be taken on the bench mark and the outlet of the drain as well as 400 or 500 feet along the drain. A back-sight is taken on the bench mark and the height of the instrument is established. A fore-sight is then read on a point at outlet of drain and at intervals of 50 feet up the drain. When as many readings have been taken for the first set-up as is convenient, a turning point is established, a new set-up is made and the work is continued. All points where readings are taken are numbered as follows: Station 0, Station 0 + 50, Station 1 + 00, Station 1 + 50 and so on; Station 2 + 93 would thus be 293 feet above the outlet. The readings are not only taken at regular intervals but at other points where there is a decided break in the surface of the ground, where there is a change of direction in the line of tile or where a lateral tile enters. At each of these stations a short stake should be driven nearly flush with the surface of the ground; also, alongside it, a long stake for a marker or guide on which the station number and depth of cut is written. The short stakes can be made of most any pieces of solid wood and the long stakes of plaster lath or similar boards.

**Establishing the grade.** There are many drains with a decided slope where the grades can be easily established with a line and gauge rod without an instrument. This method can nearly always be used in the drainage of seepy spots on hillsides. Begin by driving a 4-foot stake at each station. Then, starting at the outlet, fasten a line a definite distance above the proposed bottom of the ditch; if a 6½-foot gauge rod is to be used and the ditch is to be 4 feet deep at the outlet, then measure up 2½ feet from the top of the grade to locate the line on the long stake. Draw the line up to each of the other stakes, being sure always that there is ample fall toward the outlet. To determine the depth to dig at any point, it is only necessary to measure from the line down to the surface of the ground and subtract this distance from 6½ feet. If there is a uniform fall along the line of the drain, the depth can be kept practically the same at all points.

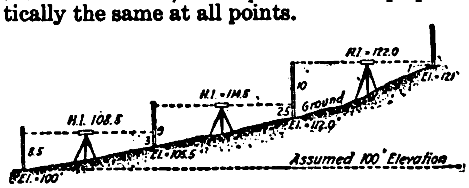



FIG. 343. Diagram showing the process of profile leveling. El is elevation; H. I. is height of instrument; and the figures give the readings of both back- and fore-sights. (See text and Fig. 344).

To compute the amount of excavation in digging a ditch for drainage or the amount of excavation or filling necessary in road work, a grade line must be established. To establish a grade for a tile drain, the elevation of the highest and lowest points must be considered. The tile must not be too deep nor too shallow. Where the land is uniform the elevation of the outlet and the highest point will usually control the grade. The best method to follow is to select trial grade lines along the line of drain until the grade and depths at the various controlling points are satisfactory. This is done by assuming the grade line to be a certain depth below the grade stake at the outlet and a certain depth below at some other controlling point, say Station 5. It is found that the elevation of Station O, the outlet, is 95 feet and the depth at that point is assumed to be 4½ feet; the elevation on the grade line would then be 90½ feet. The elevation of the grade stake at Station 5 is 96½ feet assuming the depth of drain to be 3½ feet; the elevation in grade line would be 93 feet or 2½ feet higher than at Station O. A rise of 2½ feet in 500 would be equal to a rise of 6 inches in 100 or 3 inches every fifty feet. When the elevations of the intermediate points have been determined the cuts can be computed as follows: Add the rise in 50 feet to the elevation of the grade line at Station O to determine the elevation of grade line at Station 0 + 50. The elevation of all other points on the grade line may be found in the same manner. The difference between the grade-line elevation and the surface elevation at any station is equal to the cut at that station.

Survey
between concrete slab at well
and bottom of concrete tank on hill

LEVELMAN John Smith
RODMAN Henry Brown
September 3. 1917
Clear and Warm

| STA. | B. S. | H. I. | F. S. | ELEV. | (Description of concrete slab at well) |
|---|---|---|---|---|---|
| BM1 | 8.5 | 108.5 | | 100 | Turning point 400 ft. East of BM1 |
| TP 1 | 9.0 | 114.5 | 3.0 | 105.5 | " " 800 " " " " " |
| TP 2 | 10.0 | 122. | 2.5 | 112.0 | Tank 1000 " " " " " |
| Tank | | | 1 | 121.0 | |

FIG. 344. Notebook page showing how to keep a record of a job of leveling as pictured in Fig. 343

## CHAPTER 22

# Practical Farm Drainage

*By* PROFESSOR E. W. LEHMANN *of the Agricultural Engineering Department of the University of Missouri, whose experience in this field has been referred to in Chapter 21. Drainage is not like plowing and cultivating, a work that every farmer must make an almost daily feature of his activities. But it is one that a great number of farmers have found profitable and one that a great many more would do well to study and undertake. Its relations to soil quality and condition have been discussed in Volume II, Chapter 3. In these pages Professor Lehmann takes up the actual details of planning and carrying out a drainage project, large or small.*—EDITOR.

PERFECT underdrainage has been one of the chief factors in making the land of the Middle West the highest-priced general farm land in the United States. While it is the fertility of the soil that produces the big crops, it is the indirect results of drainage which makes the production possible. This is true not only in the Middle West, but in every other part of the United States where complete drainage is practised. Good drainage is one of the first essentials of maintaining a soil for permanent agriculture. If drainage is lacking, the greatest benefit derived from growing legumes, from applying manure, and from thorough tillage will not be realized. In a poorly drained soil nitrogen-fixing bacteria do not thrive, very little of the total fertility is made available for plant growth, and thorough tillage is impossible. As far as the physical condition of the soil is concerned, the three essentials of crop production are a soil of the right temperature, right condition of moisture, and sufficient ventilation. All of these are affected by underdrainage.

**Benefits of drainage.** Drainage makes the soil firm, so that the entire field can be cultivated. The areas of waste land so noticeable in poorly drained fields are replaced by growing crops. It makes possible early cultivation in the spring as well as early cultivation after rains. It warms the soil by removing the cold ground water, by eliminating a great deal of surface evaporation, and by making possible the entrance and downward movement of warm rains. It allows better aëration of the soil, which increases the decomposition of organic matter thereby making more plant food available. It makes possible a deeper root development

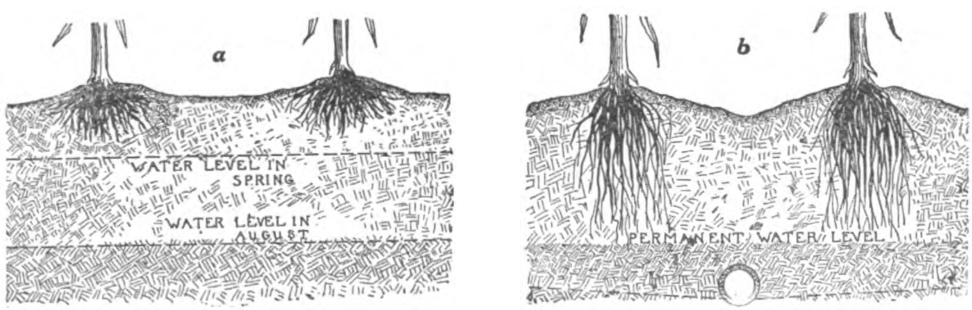



FIG. 345. Drainage stimulates deep root development. Roots held back by high water in spring cannot reach the supply in summer (*a*). When a drain keeps the water table at one place, the roots reach down to it and never want for moisture (*b*).

in plants by lowering the water table or line of saturation. Plants with a deep root development are better able to resist the effect of a drought.

Drainage increases the storage capacity of the soils, allowing the rains to soak in instead of washing over the surface. Thorough drainage prevents heaving due to frost. Less winter wheat is killed on well-drained land than on poorly drained. It improves the sanitary conditions of the surroundings and, lastly, it increases crop production enough to pay for the installation in one or two years.

**Land needing drainage.** There are a great many conditions that make drainage necessary. The most common are: Where low lands are flooded with water from higher surrounding land; where there are seepy or spouty spots on hillsides, due to a tight sticky soil underneath the surface; where nearly level fields or rolling tracts of upland do not have adequate natural surface or underdrainage; where there are marshes and swamps, and in irrigated sections where there are swamps and sloughs due to over-irrigation. Besides the 70 or 80 million acres of swamp and overflowed land that need to be reclaimed by drainage, it has been estimated that there are between 100 and 150 million acres now classed as cultivated land that could be tile-drained with profit. There are few farms that have perfect drainage. A heavy subsoil or other natural conditions may interfere with the natural tendency of the free soil water to pass downward by gravity. The result is a wet slough or seepy spot filled with marsh grass. Proper drainage is needed to make such land productive.

**Kinds of drains.** Farm drains are usually classed as open ditch or tile or a combination of the two. The vertical drain is another type which has been quite satisfactory in certain sections.

## Surface Drainage

**Open ditches.** There are two kinds of ditches used in drainage work, the surface relief ditch and the outlet ditch. The surface relief ditch is a wide, shallow ditch used in connection with a tile on nearly level bottom land that receives the surface run-off from a large area of hill land. It removes a part of the heavy rains that occur occasionally and which would otherwise cause injury. A relief ditch should be so broad and shallow that it will not be a hindrance in cultivating the field and not have a tendency to form a gully by washing. It usually follows the line of natural drainage, and may be made directly over the main tile or to one side of it. When made directly over the main tile there is some danger of washing due to the soft earth above the tile. Where the surface water from a large field is drawn into the relief drain by dead furrows or terraces it should be well sodded. Nearly all tile systems should be provided with relief ditches in connection with the mains.

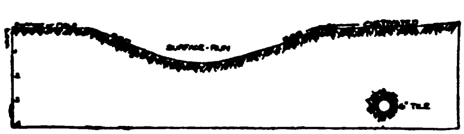


FIG. 346. Surface relief ditch combined with under drain. (This and Fig. 347, Wis. Bulletin 229.)

**Hillside ditch.** The hillside ditch is a type of surface ditch used in preventing the flow of water from hills directly upon bottom land. It is carried around the slope on a slight grade, thereby breaking the flow of water and reducing soil washing. This type of ditch is built by plowing several furrows down hill making it of sufficient depth to carry the surface water.

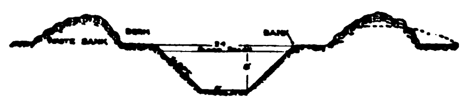


FIG. 347. Cross section of drainage ditch giving names and dimensions of parts. The right bank would be better if sloped as shown by dotted lines.

**Terraces.** The terrace is an outgrowth of the hillside ditch and is devised as a means of draining the water from hills in a satisfactory way and at the same time preventing soil washing, which is a big problem in hillside drainage. The Mangum terrace is about the best type. It is laid out with a very slight slope, usually about 6 inches fall per 100 feet. They are spaced on the slope so that the vertical distance between them is not more than 6 or 7 feet. As an outlet for a terrace, a well sodded surface relief ditch may be used if it is not convenient to discharge the water into a sink hole or wooded strip of land. A convenient method of

FIG. 347a. A large outlet ditch such as this is often a necessary evil. But it should be kept outside the cultivated area.

bu lding a terrace is to back furrow and drag the dirt toward the centre with a drag or grader. The terrace when finished should be 16 to 20 feet wide with the crown about 12 to 16 inches higher than the drain above.

**Outlet ditches.** An outlet ditch is often a necessary evil in draining swamps, bayous, lakes, and in straightening winding sluggish streams. While a ditch hinders cultivation and requires a great deal of maintenance it is the only satisfactory means of removing the water from large areas. In some sections relatively small outlet ditches used in draining a few thousand acres are being replaced by large tile drain. In localities where the value of the land does not justify an expensive system of drainage, open ditches are essential and very effective in soils of an open character. The nature of the soil allows the water to pass downward through it, thence laterally into the ditch. The soil becomes saturated before there is much flow into the ditch. In heavy clay soils open ditches afford very poor drainage. The soil absorbs the water very slowly and the greater part of it flows directly into the ditch, carrying a great deal of soil particles with it. The result is the water is not given an opportunity to replenish the moisture in the soil which is needed when rainfall is deficient.

**Design of an outlet ditch.** An outlet ditch must have sufficient capacity to carry the surface water in time of heavy rains. It should be deep enough to be an adequate outlet for tile mains when there is normal flow in the ditch. It must not be too deep in proportion to its width. A depth of 6 to 10 feet is desirable. This will be governed by the topography and type of soil. A ditch cannot be made as deep in a soil that caves easily as one that does not. The necessary capacity of a ditch determines its width. In no case should the width be less than twice the depth of the ditch. The actual dimensions have to be determined for each individual problem. If a very large area is to be drained the services of an engineer should be secured. Quite often a local man who has studied and made note of the conditions of flow in the natural drainage lines during high water is a good judge as to the necessary size of outlet ditch.

### TABLE I.—NUMBER OF ACRES DRAINED BY OPEN DITCHES

DEPTH OF WATER 5 FEET. DEPTH OF DITCH AT LEAST 6½ FEET

| GRADE | | AVERAGE WIDTH OF WATER | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Per Cent | Feet Per Mile | 6 Feet | 8 Feet | 10 Feet | 15 Feet | 20 Feet | 30 Feet | 50 Feet |
| 0.02 | 1.0 | 980 | 1,470 | 1,900 | 5,000 | 7,150 | 23,800 | 43,800 |
| 0.04 | 2.1 | 1,390 | 2,090 | 2,800 | 7,200 | 20,400 | 33,500 | 62,500 |
| 0.06 | 3.2 | 1,710 | 2,560 | 5,100 | 17,600 | 24,700 | 40,800 | 75,500 |
| 0.08 | 4.2 | 1,980 | 2,980 | 6,100 | 20,400 | 30,000 | 48,800 | 88,000 |
| 0.10 | 5.3 | 2,220 | 5,010 | 7,600 | 23,400 | 83,400 | 54,500 | 98,000 |
| 0.15 | 7.8 | 2,720 | 6,300 | 17,100 | 28,700 | 40,500 | 66,700 | 120,000 |
| 0.20 | 10.6 | 4,820 | 7,300 | 19,500 | 33,000 | 47,000 | 77,000 | 139,000 |
| 0.25 | 13.2 | 5,370 | 16,300 | 21,900 | 37,500 | 53,000 | 86,000 | 155,000 |
| 0.30 | 15.8 | 5,900 | 17,900 | 23,900 | 40,700 | 57,000 | 94,000 | 170,000 |
| 0.40 | 21.1 | 6,830 | 20,600 | 27,700 | 47,000 | 67,000 | | |
| 0.50 | 26.4 | 7,600 | 23,000 | 31,000 | | | | |
| 0.60 | 31.7 | 16,700 | 25,200 | 33,900 | | | | |
| 0.70 | 37.0 | 18,100 | 27,300 | | | | | |
| 0.80 | 42.2 | 19,000 | | | | | | |
| 0.90 | 47.5 | 20,500 | | | | | | |

### TABLE II.—NUMBER OF ACRES DRAINED BY OPEN DITCHES

DEPTH OF WATER 7 FEET. DEPTH OF DITCH AT LEAST 9 FEET

| GRADE | | AVERAGE WIDTH OF WATER | | | | | |
|---|---|---|---|---|---|---|---|
| Per Cent | Feet per Mile | 8 Feet | 10 Feet | 15 Feet | 20 Feet | 30 Feet | 50 Feet |
| 0.02 | 1.0 | 2,300 | 4,700 | 16,600 | 28,000 | 48,000 | 88,500 |
| 0.04 | 2.1 | 4,850 | 6,740 | 23,400 | 35,400 | 58,000 | 106,000 |
| 0.06 | 3.2 | 5,920 | 17,000 | 29,600 | 43,400 | 72,000 | 129,000 |
| 0.08 | 4.2 | 6,940 | 19,100 | 34,200 | 50,000 | 83,000 | 150,000 |
| 0.10 | 5.3 | 7,720 | 21,800 | 38,400 | 56,000 | 92,600 | 167,000 |
| 0.15 | 7.8 | 19,400 | 27,000 | 47,200 | 68,500 | 112,000 | 202,000 |
| 0.20 | 10.6 | 22,400 | 31,300 | 54,200 | 78,700 | 130,000 | 235,000 |
| 0.25 | 13.2 | 25,000 | 34,800 | 60,500 | 88.000 | 146,000 | |
| 0.30 | 15.8 | 27,400 | 38,200 | 66,200 | 96,500 | | |
| 0.40 | 21.1 | 31,700 | 44,100 | | | | |
| 0.50 | 26.4 | 35,400 | | | | | |

There are a number of formulas developed by the use of which, when the controlling factors are considered, the area which a ditch will drain can be computed. The accompanying tables were computed by means of Kutter's formula for average drainage conditions and are a help in determining the proper size of ditch to drain a certain area. For relatively small areas, a ditch should have a greater capacity than a large area, due to the fact that the water reaches the ditch more quickly, and less water has a chance to soak into the soil or evaporate. For this reason, for the areas above the heavy lines in table the ditches are large enough to carry off three fourths inch of water in 24 hours; for the areas between the heavy lines, the ditch will remove half an inch in 24 hours; and for the areas below the heavy lines, the ditch will remove one fourth inch in 24 hours.

To prevent caving, the sides of a ditch should be sloping. Under average conditions a 1 to 1 slope is sufficient. The areas in table above are computed for ditches with this slope. If the soil caves very badly a greater slope would be necessary, while in a stiff clay soil the banks may be left steeper.

**Location and construction of outlet ditches.** All outlet ditches should follow the lines of natural drainage as near as possible. The ditch should be staked out and grade established as outlined in Chapter 21, page 230. Nearly all outlet ditches at the present time are constructed by means of some kind of ditching machinery of which there are a great many types, designed to be used under nearly every condition. The cost of excavation by machinery is much less than by hand method. In some places ditches have been blasted very economically by means of dynamite. At the Montana Experiment Station, ditches were blasted at much less expense than they could have been dug by hand. In blasting, 2 sticks of 60-per cent dynamite were placed in holes 22 inches apart. The holes were made 2 feet deep by driving in 2-inch steel bars. Due to the soil caving, 1-inch galvanized pipe was used for loading the holes. The dynamite was put in through the pipe which was removed. The holes were filled with water over the charge, necessitating no other tamping. About 25 holes were fired at a shot, using the middle hole as a primer. Into one of the sticks of dynamite in the priming hole was inserted a blasting cap attached to a fuse, all parts being waterproofed. On the explosion of the priming charge, all other charges are exploded by concussion. After the blast the ditch is straightened up by hand.

There are many small open ditches constructed by plow and scraper. Such ditches are usually so small that they are not very satisfactory as outlets.

**Maintenance of open ditches.** The efficiency of every tile drain depends upon the condition of its outlet. There are a great many outlet ditches that are neglected, and a few years after they have been built, they are filled with mud to such an extent as to be practically worthless. The waste banks become rough and irregular, straw and cornstalks collect in the bottom of the ditch and are covered with silt and clay which gradually fills the channels. All ditches should be regularly inspected each year. All obstructions, such as trash and drift wood, should be removed. Bushes and weeds which would hinder the flow of water should be cut out. The deposit of silt along the sides and bottom of a new ditch furnish an ideal seedbed for the growth of weeds and willows, and if not removed immediately they form a lodging place for silt for future years. The method to pursue in cleaning out ditches depends on local conditions. Where ditches are spanned by bridges the equipment possi-

ble to use is often limited. In small ditches that practically dry up in the summer the team and scraper method may be used. In some cases in larger ditches silt banks and drift may be dynamited and the material carried away by the stream. A method that has been successfully used for breaking up the silt in ditches that contain 8 or 10 inches of water is to have a small flat-boat on which is installed a force pump driven by a gasoline engine. The inlet pipe to pump should be equipped with a strainer. The discharge pipe should be slightly smaller than inlet pipe and equipped with suitable fire nozzle that will deliver sufficient stream of water to break up the silt beds. Another method is to use a centrifugal pump and pump the silt over the water bank. Such a pump will remove 25 to 40 per cent solids with the water.

## Underdrainage

**Tile drainage.** An ideal system of drainage is one that is adequate, permanent, not a hindrance to cultivation, and uses the least possible land. A tile-drainage system, if properly designed, meets the requirements of an ideal system.

**History.** The pioneers in underdrainage used various methods to provide a channel for the water to discharge as it seeped through the soil. Ditches were dug and brush and twigs from trees were piled into them and then covered with earth. An improvement over this method was three straight poles, one resting on the other two at the bottom of the ditch. Some of these drains worked for a great many years. Flat stones were used, a row upright on edge along each side of the ditch with a flat stone on top. Many drains of this type are still giving good service. The first tile drains used in the United States were installed by John Johnston, a Scotchman, of Geneva, New York,

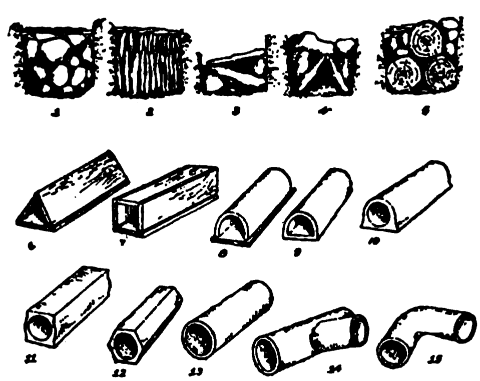


FIG. 348. Types of drain, old and new: 1–4, stone drains; 5, pole drain; 6 and 7 board drains admitting water at bottom edge; 8, horseshoe tile on board; 9–13, tile of various shapes; 14, Y-junction; 15 elbow. (Cornell Reading Course).

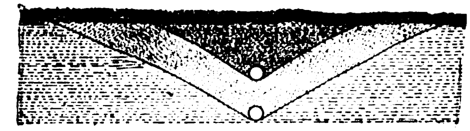


FIG. 349. The relation of the depth of tile to the width of the surface area drained (see text)

in 1835. The crude, hand-made tile used were shipped from England. A machine for making better tile was soon introduced, which greatly stimulated the installation of this type of drain.

**Principles of tile drainage.** There are certain essential principles to be kept in mind in considering a tile drainage problem. The main line which acts as an outlet for the laterals should follow the line of natural drainage as near as possible. All drains should be laid as straight as possible and in the direction of the greatest slope, an exception being where tile are used to intercept seepage water. Avoid abrupt turns and short laterals.

**Spacing and depth of tile.** The distance which the laterals are spaced apart will depend on a number of facts, chief of which are the type of soil and the depth of lateral. The depth is also determined by the type of soil. In sandy loam with a sandy subsoil where there is not an appreciable surface flow or seepage of ground water from higher land during and after storms, the laterals which are 4 feet deep may be spaced 125 feet apart. A great many people make the mistake of placing the tile too shallow in an open soil. Tile placed 4 feet deep will draw water from a greater distance each side of the line than when placed only 3 feet deep. This is illustrated in Fig. 349. In the prairie sections it is rather general practice to space the tile 100 feet apart, on an average of 3½ feet deep. On close, stiff soils the tile should be placed to a depth of 2 to 3 feet and an average of 50 to 60 feet apart. It makes little difference whether the depth is greater than 3 feet unless the tile are covered by soil which does not allow the water to seep through readily. There is really little information on the proper spacing of tile in gumbo soils. This type of soil is heavy and sticky when wet and it would seem necessary to place the tile very close together to get any results. However, reports from one experiment station state that the tile need not be laid closer than 150 feet. Other information would indicate that it is better practice not to place the tile farther than 100 feet apart in the gumbo soils or in the type of soil usually found along river or creek bottoms.

**Size of tile.** The size of tile for mains can be obtained by referring to Table III. This table is worked out on a basis of the main tile removing one fourth inch of water from the area in 24 hours. To use this table it is necessary to know the acreage to be drained

TABLE III.—NUMBER OF ACRES DRAINED BY TILE REMOVING ¼-INCH OF RAINFALL IN 24 HOURS*

| Inside Dia. Inches | Fall per 100 Feet in Inches. | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ⅜ | 1⅛ | 1½ | 3 | 4½ | 6 | 8¼ | 10¾ | 12 | 1′ 6″ | 2′ 0″ | 4′ 0″ | 7′ 6″ | 10′ 0″ |
| 4 | 4 | 7 | 8 | 12 | 14 | 16 | 19 | 21 | 22 | 28 | 31 | 44 | 60 | 69 |
| 5 | 7 | 12 | 14 | 19 | 25 | 28 | 32 | 37 | 39 | 47 | 55 | 77 | 105 | 122 |
| 6 | 10 | 19 | 21 | 30 | 39 | 43 | 51 | 58 | 61 | 74 | 86 | 122 | 166 | 194 |
| 7 | 15 | 28 | 32 | 45 | 56 | 63 | 75 | 85 | 90 | 109 | 126 | 179 | 244 | 282 |
| 8 | 22 | 40 | 44 | 62 | 78 | 88 | 104 | 118 | 124 | 152 | 177 | 250 | 340 | 394 |
| 9 | 29 | 53 | 59 | 83 | 106 | 118 | 140 | 158 | 167 | 204 | 236 | 334 | | |
| 10 | 38 | 69 | 77 | 109 | 137 | 154 | 181 | 206 | 217 | 267 | 308 | | | |
| 12 | 59 | 109 | 121 | 171 | 217 | 244 | 287 | 326 | 342 | 418 | | | | |
| 14 | 92 | 159 | 176 | 251 | 318 | | | | | | | | | |
| 15 | 104 | 190 | 212 | 300 | | | | | | | | | | |
| 16 | 121 | 222 | 248 | | | | | | | | | | | |
| 18 | 164 | 298 | 325 | | | | | | | | | | | |
| 20 | 213 | 389 | | | | | | | | | | | | |
| 21 | 241 | | | | | | | | | | | | | |
| 22 | 270 | | | | | | | | | | | | | |
| 24 | 336 | | | | | | | | | | | | | |

*Table computed by J. H. Ames, Iowa Highway Commission.

as well as fall per 100 feet. For example, to drain 150 acres with a fall of three eighths inch to each 100 feet, it would require an 18-inch tile while a 9-inch tile would drain the same area with a fall of 10¾ inches per 100 feet. To be safe in selecting proper sized mains, it is well to increase the area by 50 per cent before using the table. In this case, a tile would be selected for 225 acres instead of 150 which would necessitate a 20-inch or 10-inch tile, depending on whether there was seven-eighths inch fall per 100 feet or 10¾ inch fall per 100 feet. The latter size tile would be best to use. The size of submains may be determined in the same manner.

In selecting the proper size laterals, one should never use less than 4-inch tile. Where the land is rather flat with a fall of 4 inches or less per hundred feet, 5-inch tile would be better. Five-inch laterals are not as liable to be stopped up as smaller sizes. It has been found that it is not good practice to have the laterals more than one fourth mile in length; nor is it economical to make the laterals short.

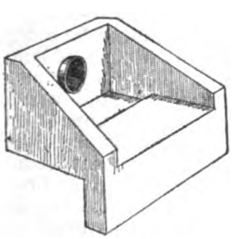


FIG. 350. Concrete outlet bulkhead, simple and cheap but permanent and efficient. A grating is sometimes needed to keep out rats, etc. (Farmers' Bulletin 806.)

**How the tile works.** Contrary to the common idea, the water does not enter the tile through its walls but at the joints between the ends of the tile, although tile should be placed as closely together as possible. The water enters the tile due to the force of gravity, and it is this force that carries the water through to the outlet.

**Tile drain outlet.** The possibility of an outlet or a place for the water to flow eventually is the first thing to look for in draining a piece of land. It is the most important feature of an effective drainage system and must be properly built and protected. When the outlet tile receives little or no protection, the earth around the tile is washed away and one tile after another then drops down and is washed out, causing a gully to be formed. Cattle and hogs in tramping around such an outlet will knock the tile out of place and partially or entirely stop it up. When soft tile are used at an outlet freezing will break them. The proper protection for an outlet should be a concrete bulkhead constructed as shown in Fig. 350.

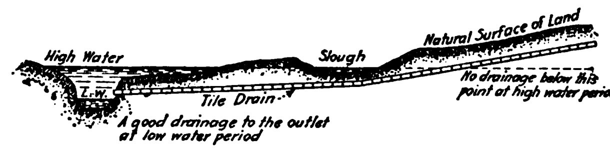



FIG. 351. The elevation of the outlet and the drain as a whole should be based on the high-water, not the low-water, level. (Minn. Bulletin 15).

A glazed sewer tile is sometimes used as an outlet. A galvanized iron pipe makes a very satisfactory outlet into an open ditch which is liable to be deepened or widened at any future time. This type of outlet is not permanent but can easily be replaced. The concrete bulkhead should be used when the outlet is into some permanent stream. A good outlet is enough lower than any point in the field so that there is no danger from back water or silt. Many tile outlets are submerged sometimes during the year, but this does no damage if the tile are prop-

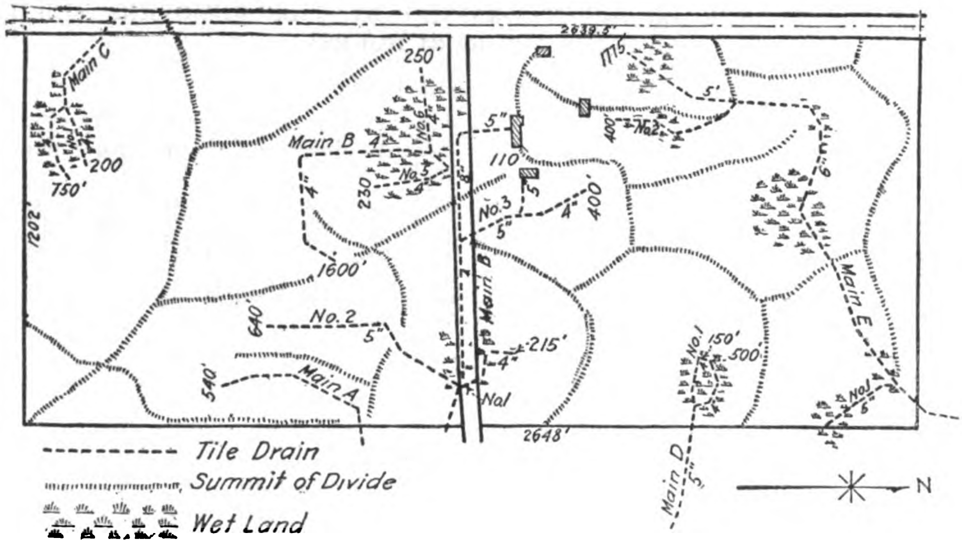



FIG. 352. Map of a drainage system showing lines of tile following the low places between the divides. Figures show size of tile and length of each run. (Minn. Bulletin 15.)

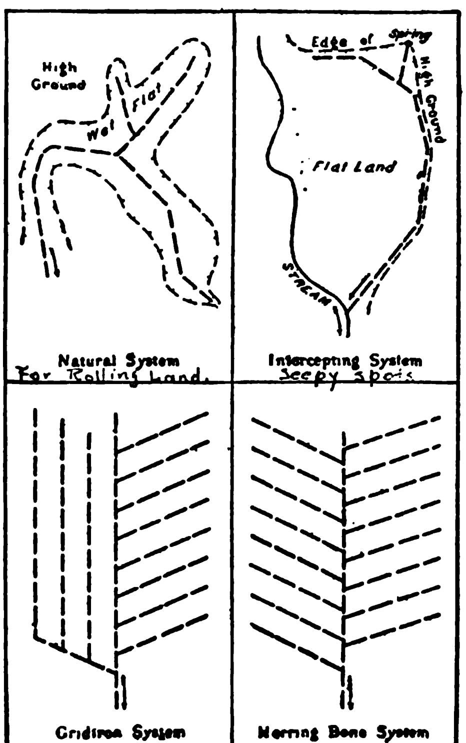



FIG. 353. Systems of tile drainage for special conditions

erly laid. To be effective as soon as possible after heavy rains, the outlet must be at a higher level than the normal water line of the ditch so as to allow free flow from the drain. In some cases this necessitates deepening the stream or grading it for a certain distance below the outlet. In many cases crooked, meandering streams can be made into effective outlets by straightening them and removing logs and brush. In some cases it is necessary to secure an outlet by draining through a neighbor's field or across a public highway. Proper coöperation between parties concerned is the best way to handle such cases.

**Draining a farm.** The first thing any one should do in preparing to drain a farm is to make a preliminary investigation to determine the best method to follow. Most farmers know the type of soil, how fertile it is, and are able to make a fair estimate of the value of crops that can be grown after drainage. Such an estimate should be a big factor in determining whether a piece of land should be drained or not. The farmer also knows the parts of the bottom land which are wettest and where the seeps appear on the hillsides. He also knows how high the water stands in the creek under normal conditions and where the natural drainage lines are in the fields. All of these facts should be considered in the preliminary investigation. The type of soil should be examined carefully, both the surface and the subsoil. The presence of a tight clay or a sandy soil would affect the arrangement of the drains very materially.

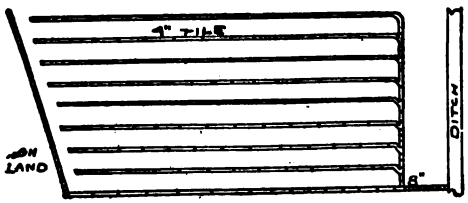



FIG. 354. An economical method of draining bottom land. The fewer junctions and outlets the better (Minn. Bulletin 15).

**Planning the system.** A system of tile drainage is composed of laterals, submains, and mains. The laterals are the branch drains that empty into the mains or submains. The submains empty into the mains and the mains carry all of the water to the outlet. Quite often a single line of tile is all that is necessary. Plans for complete drainage should be made at the outset. All mains should be large enough to carry the water from the laterals. On rolling land the natural system of drainage is used. The mains and submains follow the lines of natural drainage and lead to the laterals located in the small sloughs and draws as found on such land.

An economical system of tile drainage suitable for bottom land is one with long laterals with as few junctions and outlets as possible (Fig. 354.)

**Draining a seepy hillside.** A seepy spot on a hillside is due to the surface soil being underlaid with a tight heavy clay which outcrops somewhere down the slope. The excess water in the soil as it pours downward reaches this layer of tight dense soil and follows it to the surface. This seep water will quite often ruin the soil for cultivation for several rods down the slope. In draining such a spot the tile must be laid across the slope on the upper side of the wet outcrop and deep enough to intercept the water flowing along the tight soil. These tile can best be located while the ground is wet, or have the spot marked out during the wet period.

The method of staking out lines and establishing a grade is discussed in Chap. 21.

**Digging the ditch for tile.** After the lines have been staked out and the grade has been properly established excavation can begin. The tools used in this work for the ordinary type of soil are shown in Fig. 357. Where very hard soils or roots and stumps are encountered a pick and grubbing hoe are needed.

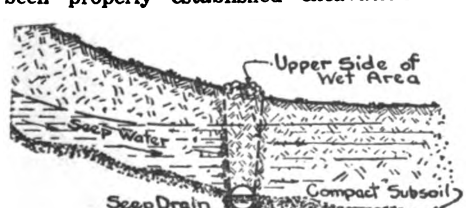



FIG. 355. Location of tile placed to drain a seepy hillside

In heavy, sticky soil the open spade can be used to advantage. The round-nose shovel is used to remove the crumbs after the first and second spading. The tile scoop is used for cleaning the bottom of the ditch to receive the tile. The scoop is made in different sizes to accommodate the different sized tile.

The excavation should begin at the outlet or lower end of the drain. The topsoil, or first spading, is usually placed on one side of the ditch and the bottom spading on the other. The ditching must be carefully and accurately done. Each part of the ditch should be tested with a gauge rod to see that it is to grade at all points, being careful to shape the bottom of the ditch to receive the tile. Proficiency in digging a ditch for tile comes only with practise. All lines should be thoroughly checked.

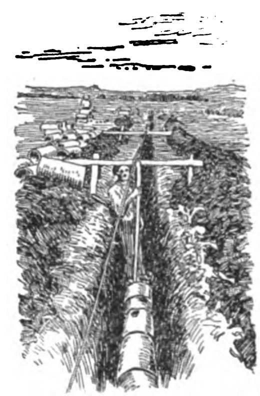


FIG. 356. Bringing the ditch to grade by means of line and gauge rod.

On large jobs a ditching machine (Fig. 250) can be used economically in excavating for tile. Where a machine is used, sight bars are established a definite distance above the proposed bottom of the ditch and are sighted on in regulating the cut of the machine.

**Laying the tile.** The tile are laid as fast as the ditch is completed. A great many tilers place the tile in the ditch by hand; others prefer to use the tile hook. It requires practice to get the tile to fit closely in the ditch. It is usually done by quickly revolving the tile until the ends make a good joint. If a space of one fourth inch or more is left between the ends of tile there would be danger of entrance of silt. In laying large tile that cannot be handled easily with hook or by hand, a derrick is used. At the end of string of tile and at sharp curves where spaces between the ends of tile are likely to occur, broken pieces of tile should be placed to keep the line from filling.

Where quicksand is encountered in digging, extreme care must be observed to keep the tile to grade. Boards are sometimes placed in the bottom of the ditch. To prevent the sand from entering the tile at the joints they should be surrounded with coarse hay or grass,

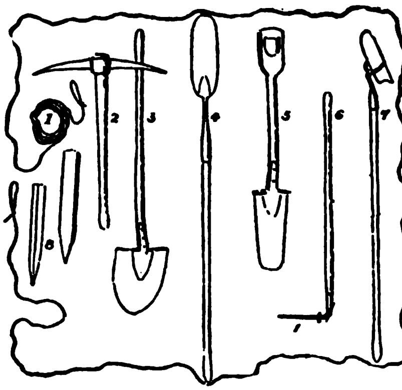


FIG. 357. Hand tools for drainage work: 1, line; 2, pick; 3, round shovel; 4, scoop shovel; 5, narrow ditching spade; 6, tile hook for lowering pipe; 7, bottom smoothing scoop; 8, gauge pegs.

burlap or tarred paper sometimes being used. If a supply of coarse gravel is at hand, it should be packed around the tile. It will be more permanent and very effective.

Proper caution must be observed in joining the laterals to mains. It is best practice to make a smooth curve so that the flow of water from the lateral into the main will be down stream. With small mains a "Y" connection is best but a little more expensive. In joining a lateral to a main it is best to connect it with the top of lateral on level with the top of main. The hole in the main may be started with a hammer or pick and enlarged by breaking off small pieces with a monkey wrench. Place broken pieces of tile around junction to prevent entrance of silt.

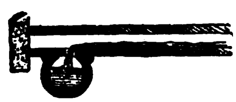


FIG. 358. One way to join lateral and main lines

**Blinding the tile.** The tile should be covered with a small amount of dirt just as soon as they are placed in the ditch. This is called blinding or priming. The tile are usually blinded by spading off the sides of the ditch, care being taken not to knock the tile out of line. The purpose of blinding is to hold the tile in place until the ditch is filled.

**Filling the ditch.** The trenches are not usually filled until after all tile are laid and blinded. One common method of filling is to use a walking plow with a long double-tree having a horse on each side of ditch. An "A" shaped drag can be used to advantage and light graders and scrapers are also used. Either of these methods is much more economical than to fill by hand. Where tile are laid in tight soils it is good practice to place the top soil directly over the tile, and the soil from the bottom of the ditch in last. In other words, the back-filling is just the reverse

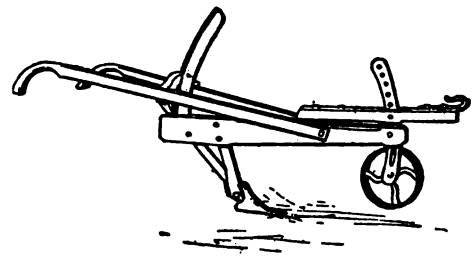


FIG. 359. A ditching plow is sometimes used in stiff soil, but it leaves a ragged top edge

of the excavation. Under certain conditions gravel or sand should be placed over all the tile to allow the surface water to pass through more quickly. This is advisable in draining an old pond or barn yard where the top soil is puddled to such an extent to prevent the passage of surface water.

**Care of tile drains.** After the tile are installed they should be watched to see that they are working properly. The condition of the soil a few days after a rain is the best indication as to how the tile are working. If a wet, seepy spot is found over a tile line it is a sure indication of an obstruction. This may be due to a broken tile or filling in of silt where the tile are off grade. Sometimes roots from trees and plants will stop the tile. No willows should be allowed to grow along a tile line unless the sewer tile are used and the joints closed with cement. Alfalfa, though a deep-rooted plant, has given very little trouble in stopping up tile. One condition where alfalfa roots would probably go into a tile is where a line passes through a dry, well drained piece of land carrying water from a wet, seepy spot. Tile lines draining a seepy spot or spring should be carefully inspected each year.

**Cost of draining.** The cost of drainage work consists primarily of the cost of excavation and cost of materials. In large drainage projects the cost of engineering service, legal proceedings and organization become rather large items. In open ditch work the cost of excavation may be more than ninety per cent of the total cost. In tile drainage the cost of excavation varies from fifty to seventy-five per cent of the total. All of these items vary greatly in different localities.

**Cost of tile.** Drain tile, if bought in carload lots directly from the factory, are much

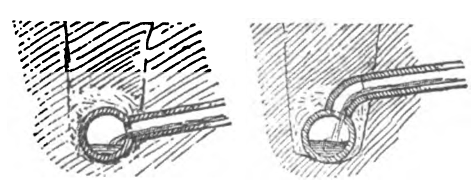
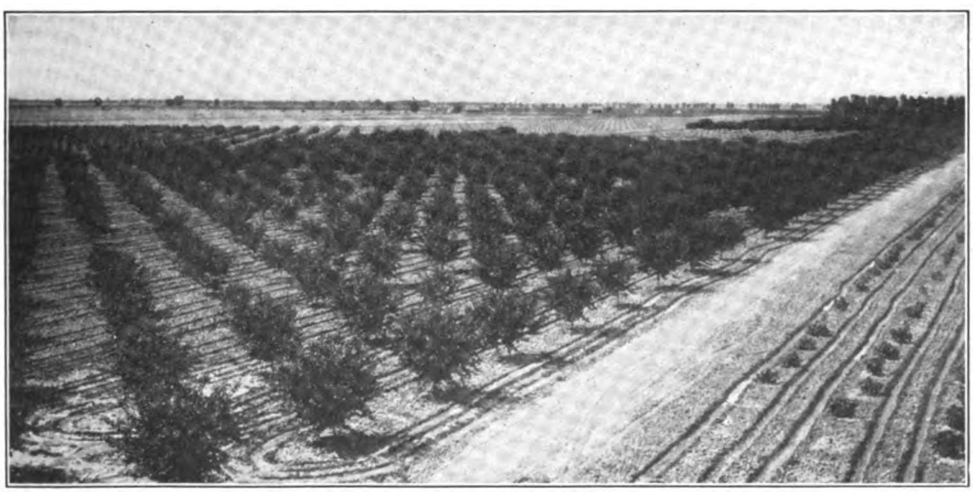


FIG. 360. Two other methods of joining mains and laterals. *At left*, the better; and the commoner of the two

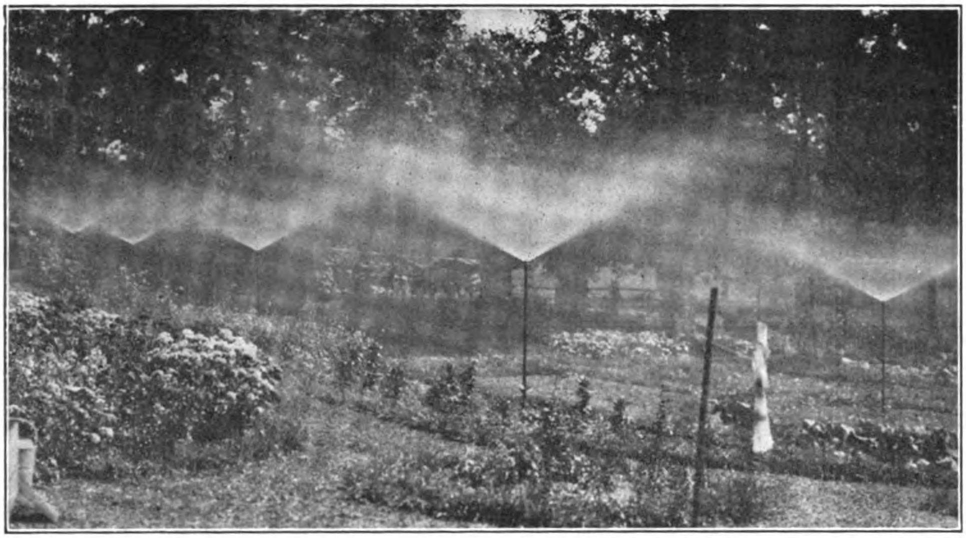
The furrow method of irrigating, usually practised on tilled land, but here on a field of timothy

A large market garden establishment with many acres under irrigation by the pipe-line system

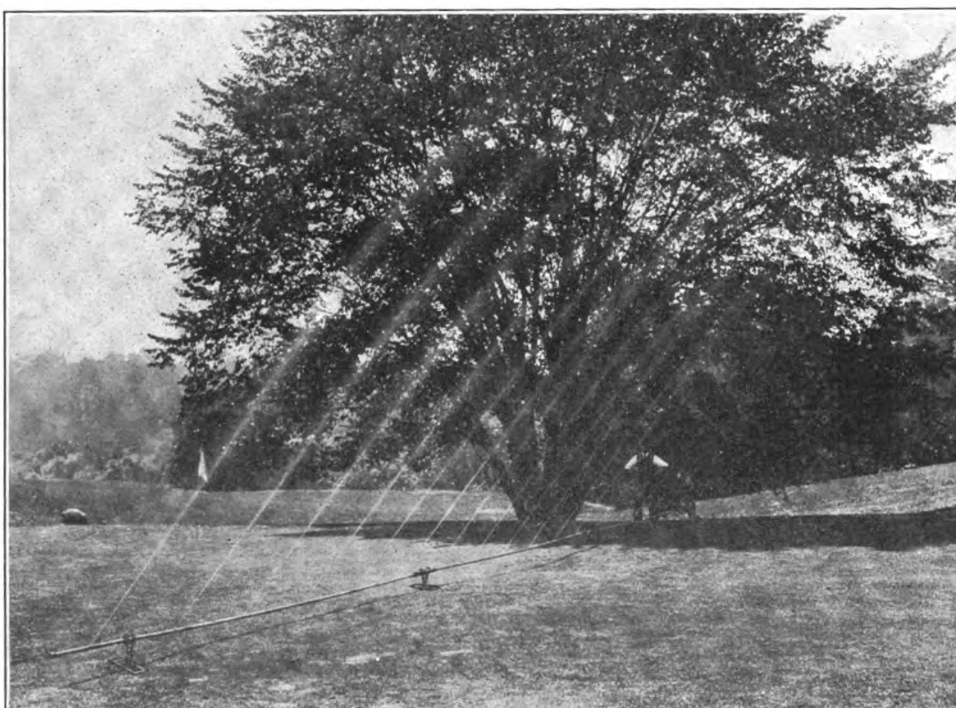


Furrow irrigation of an orange orchard. Thorough preparation of the surface before planting is essential

THERE IS AN IRRIGATION SYSTEM FOR EVERY SET OF CONDITIONS UNDER WHICH ARTIFICIAL WATERING IS NEEDED



The standpipe system, with either stationary or revolving sprinklers, is excellent for permanent flower and vegetable gardens



Lawn perfection can be maintained by means of a portable nozzle-line system with an automatic pipe-revolving device

OVERHEAD OR SPRINKLER IRRIGATION, AN INVENTION OF THE TWENTIETH CENTURY, IS OPENING THE WAY TO NEW POSSIBILITIES IN HUMID REGIONS

FIG. 361. Filling a ditch with a plow and long doubletree

cheaper than when purchased from local dealers. Table IV is representative for tile delivered at middle western railroad stations.

TABLE IV—COST AND WEIGHT OF TILE (1919)

| SIZE | FEET IN 15-TON CARLOAD | PRICE PER 1,000 FT. | PRICE PER ROD |
|---|---|---|---|
| 4 inch | 5,000 | $ 36.00 | $ .59 |
| 5 " | 3,000 | 49.00 | .81 |
| 6 " | 2,500 | 66.00 | 1.09 |
| 8 " | 1,500 | 117.00 | 1.83 |
| 10 " | 1,000 | 175.00 | 2.90 |
| 12 " | 850 | 200.50 | 3.30 |

Prices per rod and per 1,000 ft. are on the same basis.

**Cost of excavating and laying.** The cost of excavating the ditch and laying the tile depends upon labor conditions, type of soil, depth of drainage, and size of tile. The cost of complete drainage is often as much as $25 to $50 an acre.

The cost of excavating increased practically 75 per cent. during the years 1916 to 1919. But land values have also increased and owners of land that needs drainage cannot well afford to hold back on account of high prices. The following figures give costs per rod for digging trench, laying the tile, and back filling where the wages for good diggers are 40 to 50 cents an hour.

| SIZE OF TILE INCHES | DEPTH IN FEET | | |
|---|---|---|---|
| | 3 | 4 | 5 |
| 4 to 6 | $ .60 | $.95 | $1.45 |
| 7 to 8 | .76 | 1.20 | 1.75 |
| 9 to 10 | .87 | 1.36 | 2.10 |
| 12 | 1.00 | 1.55 | 2.04 |

The cost of back filling alone is not more than 3 to 5 cents a rod, if a team and plow are used, but prohibitive if done by hand.

The data on this page make possible an approximate estimate of the cost of the laterals of a system. To this must be added the cost of mains, submains and back filling.

| | | | | | | |
|---|---|---|---|---|---|---|
| Feet between laterals . | 50 | 66 | 80 | 100 | 150 | 200 |
| Feet of tile per acre . | 872 | 660 | 545 | 436 | 291 | 218 |
| Rods of tile per acre . | 53 | 40 | 33 | 26 | 18 | 13 |

**Kinds of tile.** Burned clay and concrete tile when properly made give equally good results. A poor quality tile of either kind will disintegrate when in use. Contrary to the general idea clay tile should be hard burned, not porous. A vitrified clay is more durable and better than the salt glazed variety. The following general requirements are from Bulletin 31 of the Iowa Engineering Experiment Station: "All drain tile shall be good, sound tile, of first class quality. They shall be entirely free from cracks and fire checks extending into the body of the pipe in such a way as appreciably to lower its strength. No pipe shall be accepted having pieces broken out in such a way or to such an extent as appreciably to affect the strength of the pipe, or to permit the entrance of soil.

"The pipe shells shall have uniform, strong, dense structures throughout, without serious flaws or weak spots.

"All pipe shall give a clear ring, when stood on end or laid on one side, evenly supported at the lower end, or along a line of one side, and free elsewhere, and tapped with a light hammer while dry.

"All pipe shall be regular and true in shape. The average diameter shall not be more than 2 per cent. less than the specified diameter. No two diameters of the same pipe shall differ from each other more than 7 per cent. nor shall the average diameters of adjacent pipe differ more than 4 per cent.

"Pipe may be furnished in lengths of 1, 2, 2½ and 3 feet, but 1 foot lengths shall not be used for sizes more than 15 inches in diameter. No pipe, designed to be straight, shall vary from a straight line more than 1½ per cent. of its length.

"If cement tile are used, they shall show a uniform, dense structure, with clean aggregates, well graded as to size of materials, and with the grains and pieces of aggregate well coated and the pores well filled with good Portland cement. There shall be no spots of specially great porosity. Fractured surfaces shall show broken pieces of aggregate firmly bedded in the concrete. The general appearance of the material shall be at least equal to that of first class gravel concrete, in these proportions: 1 part first-class Portland cement; 2 parts clean, coarse sand; 1 part pebbles, from 1 inch to half the thickness of the tile wall in diameter."

Drainage records or maps usually show all lines of tile. Such a record is important

FIG. 362. The kind of tile *not* to use. It is poorly made and will soon break down and cause trouble and expense.

in the location of lines of tile when the system is extended. It is also of value if the farm is sold. Fig. 352 is an example of a good drainage map.

**Drainage of irrigated land.** It has been estimated that more than one million acres of land in the irrigated sections of the United States need drainage. The greater part of this need of drainage is brought about due to over-irrigation, also to waste from canals. Quite often the lower lying lands are injured by the seepage from higher land. It is necessary to find the source of the damaging water to be able to locate lines of tile intelligently. The drains must be located to intercept the water before it does any damage. After the intercepting drain is installed and the seepage from outside sources cut off the natural drainage of the area usually is sufficient to take care of the water applied.

**Drainage laws.** Nearly every state has a general drainage law which gives the land owners authority to form drainage organizations of a coöperative character. Laws are always necessary in the construction of large drains in which a number of people have a common interest. While the laws vary in detail in the different states, they are practically the same. The essential features of a drainage law according to C. G. Elliott, formerly of the United States Department of Agriculture, are: "First, the right given to property owners under certain prescribed conditions to petition the proper authority for the construction of drains which will be of public benefit; second, provision for making and collecting assessments to defray the cost of the work, and also for the appraisement and payment of damages to property incident to such construction; third, the establishment of the perpetual right of land owners included in the district to use the ditches or drains which are constructed; fourth, authority under proper legal regulation to incur debt and sell bonds for obtaining money with which to perform the public part of the work."

## Special Drainage Systems

**Surface inlets or vertical drains.** Surface inlets are used to allow the surface water to flow directly into the tile without seeping through the soil. For this reason, they are of great value in dense soils in depressions where the water collects and would drown the plants if not removed. In draining barnyards and feeding lots where the soil is of a clay formation and is puddled by tramping, surface inlets should be used. The simplest type of surface inlet is to have a part of the trench above the tile filled with rock or broken stone. A convenient form of surface inlet is a large sewer tile with side connections for the drains and provided with a grate at the top. A concrete box also makes a very satisfactory surface inlet. A surface inlet made of either a concrete box or sewer tile should be made deeper than the drain so that any sand or silt that is washed in will not be carried down the tile.

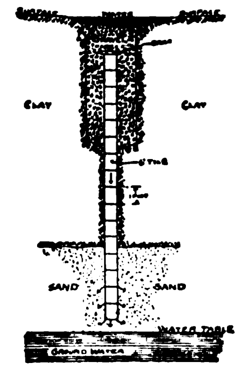


FIG. 363. A vertical drain that may serve as an outlet for a lateral line or, by itself, drain a pot-hole. (Wis. Bulletin 229.)

**The silt basin.** The silt basin is a small well for collecting the sand and silt that is carried along in the tile. It may also be used as an observation well. The silt basin is needed most in sandy soils where there is a long drain or where the grade decreases, thus tending to deposit silt. The combined inlet and silt basin are often used at the upper end of a line. The silt basin is constructed of either sewer pipe or a concrete box. The bottom of the basin should be carried down two or three feet below the outlet tile.

**Collecting basins or relief wells.** Relief wells are used in connection with a tile drain to intercept seepage water which percolates down a slope. They are very useful in the drainage of irrigated land where the seepage water flows 8 or 10 feet under the surface. The tile line is installed to the ordinary depth and is supplemented with wells bored at intervals in the bottom of the trench to a sufficient depth to provide a passage through which the water may rise to the drain.

**Drainage wells.** In limestone areas there are many sink holes that furnish outlet for drainage systems. In the same type of soil wells are bored and

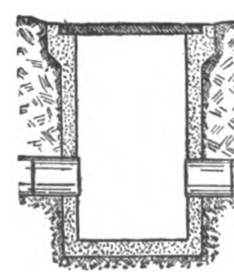


FIG. 364. A combined open catch basin, silt basin and inspection basin. (Kansas Report.)

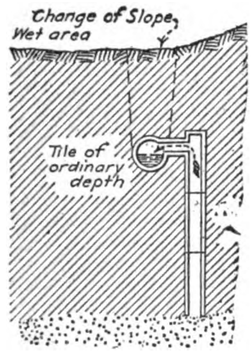



FIG. 365. Relief well for bringing water from below up to the drain line.

used for the same purpose. There are single wells in use that are an outlet for a system of drainage for more than 1,000 acres. Such a well must be properly curbed to prevent it washing. This type of outlet for drainage water is not always advisable. This is especially true in closely settled communities where the water supply for the home is used from the same type of wells and would be liable to contamination from the field drainage.

**Drainage of the home surroundings.** One of the essentials of a good house location is to be well drained. Where the natural drainage is not perfect, artificial drainage should be provided. This is necessary not only from a standpoint of health, but also of convenience and a means of providing better growth of plants in the yards and gardens. A sanitary barnyard requires that it be well drained. Eaves troughs and down spouts should be provided for all the buildings. Where a cistern is not used they should be connected to a tile drain. A greater part of the mud common to the average barnyard is due to the water flowing from the roofs of the barns and sheds. Ample drains with surface inlets should be provided for the feed lots. Surface relief ditches should be used to divert any water from higher land from flowing into the barnyard. The foundations of all the buildings should be well drained, especially the house. Drains extending underneath the cellar wall will prevent water entering the cellar.

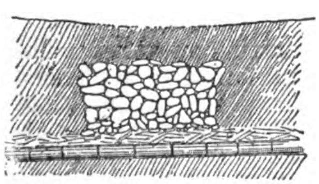


FIG. 366. Blind inlet or drainage well sunk below the surface to permit cultivation.

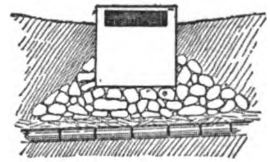


FIG. 367. Stone drainage well and screened wooden box that serves as a filter. (Cornell Reading Course.)

**Road drainage.** Proper drainage is one of the first requirements of a good road. There are three forms of water that must be removed from a road to drain it properly. The surface water on the top and sides of the road, the ground water in the road bed, and the flood water.

To secure good surface drainage the road must be properly graded and crowned, having the crown not less than 24 to 30 inches above the flow line of the side ditches. The crown should be kept smooth by dragging, keeping all ruts filled. The side ditches should be properly maintained to prevent them from forming gullies. The ground water should be removed or lowered by tile drainage. Often one line of tile laid under the shoulder of the road on the upper side is all that is necessary. Where the road is flat a line on each side is usually better than one under the centre of the road. To take care of flood water by conducting it across a road, proper sized culverts should be selected for the area drained. Quite often a relatively small concrete culvert can be substituted for a long dilapidated wooden bridge which is always a source of danger.

**Profits from drainage.** The profits from drainage are manifold. The increase in production and the rise in value of land are the most noticeable. There are thousands of acres of once practically worthless land that have been transformed by drainage into productive farms that sell for $200 an acre. Many acres that have been cropped at a loss for years double their production after drainage. Every farm that has a few wet acres is farming at a loss until they are drained.

Drainage is also profitable from a standpoint of health. By drainage, the mosquito pest is partially or entirely eliminated, reducing the malaria in the community. In one district malaria was reduced 70 per cent after drainage. The health condition of the farm animals is affected by drainage. An important feature in combating hog cholera is to have well-drained lots. Sickness and disease are very costly, so an investment that will improve health conditions will pay big dividends.

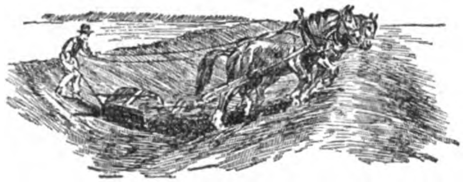


FIG. 368. Using the scraper crosswise of the furrow in making an irrigation ditch (see text, p. 252)

# CHAPTER 23

# Practical Farm Irrigation

*By* PROFESSOR R. P. CLARKSON *(see Chapter 14), who discusses the engineering details of ordinary irrigation on and under the surface, and* F. F. ROCKWELL *(see Chapter 11), who takes up overhead irrigation and its equipment. When we speak of irrigation work we think first of the immense projects of the West, which impound millions of gallons of stream water and provide moisture for the needs of many settlers and their many cultivated areas. The details of these enterprises are, however, of no practical interest to the small, individual farmer. He wants to know (1) how to carry out irrigation plans and projects on his own place, when this can be done; and (2) how to handle and distribute the water supplied to him at the edge of his fields by the local large-scale project upon which he depends. These problems are the ones treated in this chapter.*—EDITOR.

THE value of irrigation, its purposes and its various relations to soil management principles, are treated in Volume II, Chapter 3. This article treats of only the engineering side of the subject, the practical details of things to do, how to do them, and what to do them with.

A good general lays out his plans carefully before starting anything. The first step in irrigation should not be taken until the entire campaign is planned out. Determine the needs of your land, the nature of the crop, the soil conditions at the time, the water available, the money and time at your command, any expectations of the season that can be estimated in advance, in fact every feature that is likely to affect results; and then determine the method of irrigation to be adopted.

## Principles of Irrigation Practice

The first step in any case is to study the slope of the ground and carefully prepare the surface. It must really be quite well graded, gulleys and hollows must be filled in, while ridges and humps must be leveled.

**Leveling the surface.** This is best accomplished in 2 operations: (1) Go over the land and grade roughly any particular spots that need attention. (2) Follow up with plow and harrow over the field, and, if necessary, with some type of drag or scraper, the split-log drag (p. 272) being useful and easily made. A light U-shaped scraper formed of a 2-inch plank placed on edge will prove even more satisfactory. The dragging should take place in both directions, the breaking up of the field by means of plow and harrow need, of course, be done but once.

FIG. 369. Leveling the surface with a home-made plank scraper, preparatory to irrigating

To be successful the land levels must

FIG. 370. Finishing a small ditch with an A-shaped plank scraper

not be determined solely by the eye. Stretch a cord between stakes and grade to the cord. The surface must not be horizontal, indeed this condition could not be attained on many farms, but the surface of any particular field should be flat and even, not broken by hillocks which would remain dry, or by hollows and dead-end ditches which would receive more than their share of water.

**Preparing side hills.** On side hills of any considerable steepness of grade, the land must be terraced to accomplish anything like even distribution of water. This terracing is done by first breaking the field with plow and harrow to make it workable. The best plan is then to decide on the distances between terraces. They should be small and close together so that the field has in reality a sort of saw-tooth surface down hill. Oftentimes the whole work required can be done with a plow turning out furrows the proper distance apart, say 4 or 5 feet, and then grading the intervening land to a gentle slope from the top of one furrow to the bottom of the next lower furrow. This does away with the necessity of removing the topsoil during grading operations and restoring it afterward. The conservation of the topsoil is, however, sometimes required where a thin topsoil and poor subsoil are encountered.

## Methods of Irrigating

**Furrows and flooding.** With a terraced hillside and, in fact, with practically all steeply sloping land, the flooding from a canal at the top of the slope is the easiest and cheapest method of getting water on the surface. If it is a long hill several canals may be laid out at intervals of perhaps 50 to 100 yards down the hill, depending on the nature of the soil. The water is led into each of these canals, the canals are dammed up by methods described later, and the water rises and flows over the side of the canal. The grade of the canals must be carefully established so as to give a gentle slope with a fall of, say not more than 1 foot in 1,000 to allow the water to flow properly. The water, when it rises in the canals, must flow over the bank in a more or less unbroken sheet. To assure this the edge of the bank over which flow takes place must be leveled accurately. At the bottom of the hillside a canal should be placed to catch the surplus flow and direct it to further irrigating purposes on the lower lands.

**Bedding layout.** If the ground is practically level a bedding method may be employed. The land is plowed in ridges from 12 feet wide for hand cultivation to 25 feet or more wide for horse machinery. The result is really a series of wide but very shallow ditches, the earth being all worked in so as to give merely a smooth surface everywhere. Along the crest of each ridge a small distribution canal may be run from the main supply canal at the head of the ridges. These supply canals are about 100 yards apart, and divide the field into plots of that length, the distribution canals and ridges being parallel to the length of the plots. At the bottom of the depression between the ridges may be placed open drainage canals or tile underdrains the method of laying the tile being described in Chapter 22.

**Orchard irrigation** is becoming more or less extensively practised, the furrow and flood system being very common and simple in this connection. Occasionally the bedding layout is used, the distribution furrows being run between the trees and so spaced as to throw the rows of trees into the depressions. A modification of this, however, requires only a single distribution furrow alongside each tree row, the land being sloped slightly from the furrow to the opposite side of each tree where

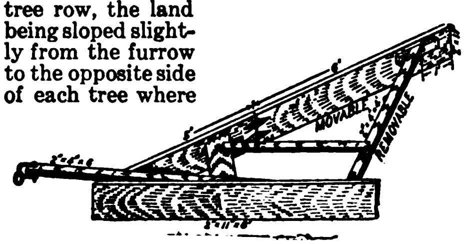


FIG. 371. Terrace drag or A-shaped scraper used in hillside irrigation and in making small ditches (Farmers' Bulletin 882).

the earth is piled into an embankment. This sloping can be done with a hoe at each individual tree, the furrow side being cut down so that flooding over the side is permitted only at the tree point. Thus there is a little bed or check at each tree which may be flooded as desired.

Vineyard irrigation is practised in both of the ways outlined above.

**The irrigation level and its use.** The most convenient form of cheap level for use in almost any farm operations which do not extend over any great distance is made by fastening a good carpenter's level to a well-made straight edge 20 feet long. At each end fasten and firmly brace a leg say 3½ feet long. One leg is best made adjustable to slide so that grades may be determined with it. The shorter leg is placed on the surface of the ground at the start of a ditch or grade line, and a hole is dug for the longer leg to such depth that the straight edge is parallel. The difference in length of the legs then gives the fall in grade for the 20 feet in the direction of the longer leg; multiplied by 50, it is the total fall per 1,000 feet.

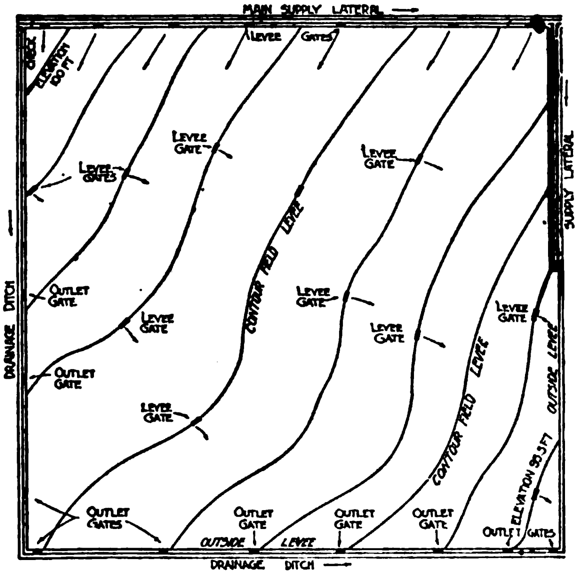



FIG. 372. Rice field laid out for irrigation by flooding. Note that there is only about 7 feet difference in elevation between the upper left-hand and the lower right-hand corners. This makes less than a foot of fall between each two levees. (Calif. Bulletin 279.)

When one hole is dug and levels obtained, the short leg can be placed in that hole and a second hole dug for the longer leg until a level is again obtained. This operation can be repeated to the end of the line, then the ditch excavated to the grade joining the bottoms of the holes, stakes driven, and a cord stretched, to make sure there are no intermediate humps and hollows. It is a good plan to check the grades over again with the level after the ditches are opened up. The flowing water will give a good indication of the evenness of the grade.

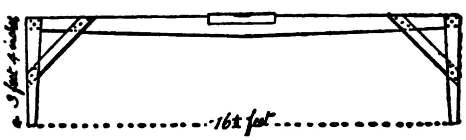



FIG. 373. Irrigation level. The dimensions (16½ x 3⅓ feet) are in practically the same proportions as those given in the text (20 x 3½ feet).

**Cost of preparing land.** Dr. Elwood Meade, a well-known authority on irrigation subjects, states that the cost of preparing the land for irrigation is from $3 to $30 per acre. The flooding method is, of course, usually the cheapest method and frequently costs considerably less than $3 per acre irrigated. Unless some particularly expensive obstacle is encountered, the cost will seldom go over $4 or $5 per acre.

**Pumping irrigation water.** In many places irrigation is impossible without pumping; this type is always very costly, especially when compared with some neighboring project in which water is obtained from reservoirs by gravity flow. Low-head, large-volume pumping has been worked out by means of the development of centrifugal or turbine pumps and on a big scale it is found to be economical. Small volume pumping, however, depends almost entirely on the windmill or oil engine or, in rare cases, the farm steam engine.

With the many disadvantages attached to the pumping of a water supply, there go also some advantages among which two in particular stand out: (1) There is always a high degree of control of quantity of water and period of distribution. (2) There is no controversy over sharing the use of the supply with

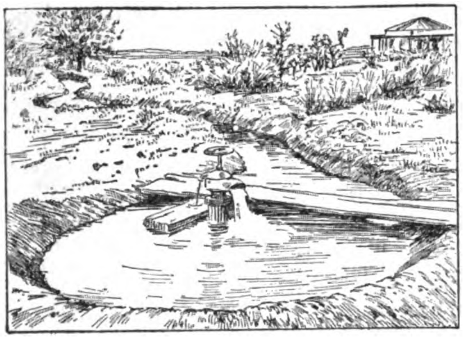


FIG. 374. Many irrigation projects in the Southwest are supplied from flowing wells such as this

others. In other words, your pumping plant is independent and in control entirely of your operations.

Frequently underground or well water is the only source of supply for pumping, and through the Middle West the windmill adapts itself particularly to these conditions where the operation of irrigation is on a small scale. However, the small size and power output of windmill units make them a highly expensive and more or less undependable source of power for acreage irrigation.

The first cost of pumping plants for about 15 installations in the South and Middle West where the head of water pumped was about 20 feet and the average acreage treated was about 200, was about $15 per acre, while the annual cost per acre was slightly under $7. With plants having heads averaging 40 feet and supplying on an average only 100 acres, the first cost was about $25 per acre and the annual cost about $12 per acre.

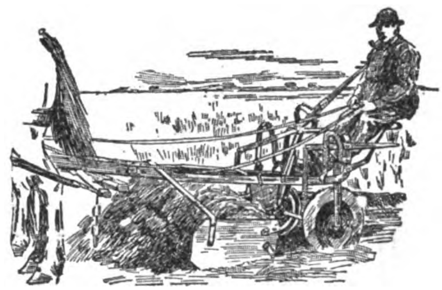


FIG. 375. Where the going is firm a wheeled scraper will do more and quicker work in leveling and ditch-making than the ordinary drag type (Fig. 369).

**Practical considerations.** It would not be advisable to irrigate all land which requires it. A practical consideration of costs is necessary in each case. Some fields are so low or the soil is so heavy that a system of irrigation would, of necessity, require also a system of drainage to prevent the fields being turned into swamps and marshes. In this case the total cost of the irrigation and drainage might be very much greater than the possible value of the additional products obtained from the land as a result of the treatment. To take another case, if the land is situated far above the water supply, the cost involved in raising and storing the water may be prohibitive.

Cost, not physical conditions about the farm, is usually the only obstacle in the way of irrigation. Usually where it pays at all, it pays well, for it makes possible a crop which should return in a very few years the total outlay involved.

**Source of water supply.** The supply of water involves the most serious part of any irrigation project. For small garden and market farming, wells can as a rule be depended upon. For fairly dry regions, however in the case of irrigation over a number of acres, wells are not dependable, except for partial service.

The requirements for a project of considerable size are such that only streams, lakes or springs can be relied upon, unless unusual conditions as to flowing or artesian wells are available. Even then, after a period of use they have been found to require expensive pumping to keep up their supply. In some cases as in the West, large, artificial storage basins or lakes are created by proper engineering measures, but as a rule this form of water supply cannot be afforded unless a very large project is contemplated. A small, artificial pond, unless continually fed by streams or springs would not be a dependable source of supply.

**Quantity of water required.** A number of factors enter into a study of the amount of water required to irrigate each acre properly. The nature of the crop is important as some plants require more moisture than others, which results in either a larger amount being used at each operation or more frequent operations. The climate affects the evaporation and thus the total amount of water that must be applied in order to give the crop a certain amount. The nature of the soil treated affects the absorption and retention of the water. Lastly, the subsoil affects the water

requirements through absorption or drainage action. An examination of each of these controlling factors must be made before the layout of any irrigation system, in order that the water requirements may be met not only by the source of supply, but by the various ditches and canals whose size and grade are designed with a view to a definite water-carrying capacity.

The following table indicates the effect of different types of soil, the absorption figure being for either surface or subsoil:

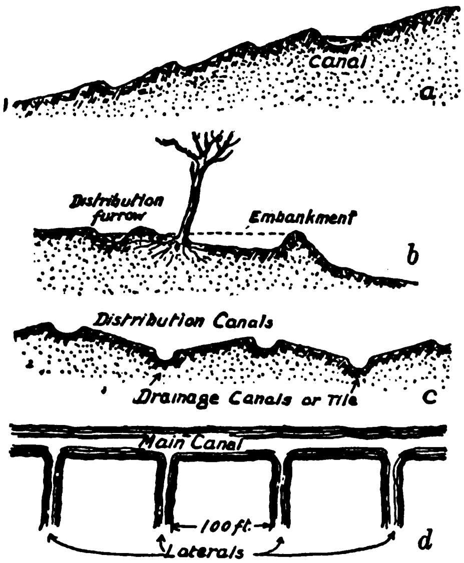



FIG. 376. Diagrams of different irrigation methods: *a*, section of hillside terraced for furrow and flooding system; *b*, section showing orchard irrigation details; *c*, section and *d*, ground plan of the bedding layout. In each case the slopes are exaggerated to illustrate the principles. (See text p. 247).

| SOILS | WATER | |
|---|---|---|
| | ABSORBED | EVAPORATED IN 3 HOURS |
| Sandy . . | 25 to 30% | 55 to 70% |
| Loam . . | 50 | 25 to 35 |
| Heavy Clay | 60 to 80 | 20 to 25 |

This table shows that (a) the soils which absorb the most water retain the most; and (b) the finer-grained soils such as loam and clay absorb the most water. From study along these lines, it is suggested that a soil which contains 20 per cent sand should be irrigated once in 15 days, while a soil having 80 per cent sand requires an application of water every 5 days.

**Conveying the water.** The following table gives the amount of water required per acre, for various depths, together with the flow required, assuming all the water is put on the land in 3 hours.

| AMOUNT | FLOW IN | |
|---|---|---|
| | SECOND FEET | GALLONS PER MINUTE |
| 1 acre inch . . . | 1/3 | 151¼ |
| 1½ acre inches . . | ½ | 226⅞ |
| 2 acre inches . . | ⅔ | 302½ |
| 3 acre inches . . . | 1 | 453¾ |
| 4 acre inches . . | 1⅓ | 605 |

An acre inch is the amount of water required to cover an acre uniformly 1 inch deep. It equals 3,630 cubic feet; or 27,225 gallons.

One second foot is a cubic foot per second. It equals 1 acre foot in 12 hours and 6 minutes; or 1 acre inch per hour; or 7½ gallons per second.

The size of ditches required depends on 3 things: (1) the amount of water which must pass a given spot; (2) the seepage and leakage losses, and (3) the greatest velocity of the water which will not cause erosion. This velocity depends to some extent upon the slope of the ditch. The usual maximum velocity allowed in irrigation canals is 3 feet per second. The aim is to give as high a velocity as will not cause serious erosion of the soil and yet will prevent the deposit of silt in the main canals. The grades allowed vary from an inch or two per thousand feet to 1 foot in 100 feet. With the slighter falls, large canals must be used, while with the greater slopes the cross section can be correspondingly smaller. The carrying capacity of any ditch is its cross section in square feet multiplied by the velocity of the flowing water in feet per second.

Where wooden and iron or stone aqueducts or pipes are used the grade is made as steep as practicable, so as to make the necessary construction as small and thus as cheap as possible. All wooden or other construction in connection with running water must be made very heavy and substantial. Water is a very heavy substance and in motion can exert tremendous force. Wherever possible, bolts and lag screws should be used in place of nails or spikes.

**Measuring water.** The simplest and most accurate device for general use in water measurement is a weir specially formed and set to make calculations easy. It consists of a flat board or panel set on edge vertically and extending across the stream. A rectangular notch is cut in from the top edge of the board, the edges of the notch being beveled to flare downstream. The edge of the weir must be horizontal. The width of the notch

and the height of the surface of the water above the horizontal edge of the notch are the two measurements which must be carefully observed. The following weir table gives the discharge from such a weir in cubic feet per minute per inch of length for varying depths of water above the edge of the notch in the weir:

| DEPTH IN INCHES | DISCHARGE | DEPTH IN INCHES | DISCHARGE |
|---|---|---|---|
| 1 | 0.4 | 8 | 9.1 |
| 2 | 1.1 | 9 | 10.8 |
| 3 | 2.1 | 10 | 12.7 |
| 4 | 3.2 | 11 | 14.6 |
| 5 | 4.5 | 12 | 16.7 |
| 6 | 5.9 | 13 | 18.8 |
| 7 | 7.4 | 14 | 21.1 |

It is important to obtain the depth of the water by measuring from its surface, not directly over the notch but some distance back of it because the water surface will slope downwards as the weir is approached from upstream, because of the velocity of the water as it runs over the weir. The weir is usually placed just below the head gate and thus measures the total intake. Its construction is so simple and cheap that it can be used in any number to check up water quantities.

**The canvas dam.** It is convenient to have a movable arrangement with which to dam up a ditch, and to meet this need the canvas dam has proved very satisfactory; it may be moved along a ditch or transferred to another at will. It consists of a canvas square large enough for the ditch, and usually about 4 feet on a side. One edge of this is tacked between 2 wooden strips which project a foot or two on either side so as to rest over the edge of the ditch. Near the top edge of the canvas and just below the strips, in the centre of that edge of the canvas, is an opening, perhaps 8 inches square, covered with a canvas flap one edge of which is held between

FIG. 377. A hillside orchard terraced so that the bedding system may be used, three or more lateral ditches being run along each terrace

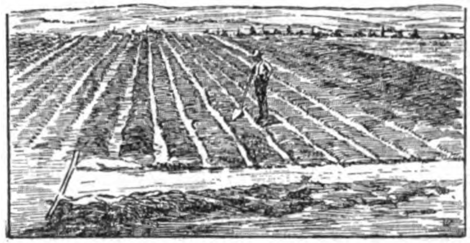


FIG. 378. Large alfalfa field irrigated by means of lateral furrows supplied from the main canal in foreground. The water is being turned into them by the canvas dam in the left foreground.

the strips. When in use the dam is laid in the furrow with the canvas extending up stream, the flap side up, and the strips resting across the furrow. The bottom and sides of the canvas are loaded with earth to hold them down. Thus placed it effectually blocks the furrow and raises the water. By means of the flap and opening, the level can be fairly well regulated.

Sometimes a flat piece of thin metal with a handle on one side, or a contrivance of 2 pieces hinged, with handles on each (Fig. 146, Vol. II) is used as a dam; for small furrows either is quite satisfactory.

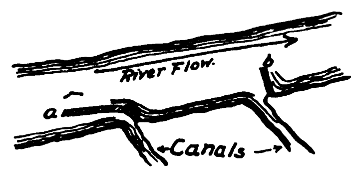



FIG. 379. Wing dams for tapping a large stream. *a*, longitudinal, *b*, cross stream type.

**Wing dams.** For the extensive use of water from large streams, some convenient method of tapping the stream has been found necessary. The usual plan, if the level of the stream is to be raised only a few feet, is to build a wing dam of either the longitudinal or cross-stream type. A point is picked out where the greatest fall of the stream occurs, and a dam is built parallel with the shore from the head of the fall down to the entrance to the irrigation canal. Below this entrance the dam curves to shore. This kind of dam may be simply built and forms a sort of flume in which the level of the water along approximately its entire length is the same as at the flume intake. It is not always essential that it be absolutely tight. Often an earth and stone dam is sufficient.

Where the fall is more rapid the cross stream wing dam is used. This is a simple dam extending straight out into the stream, the canal entrance being, of course, up stream from the dam. Such a dam

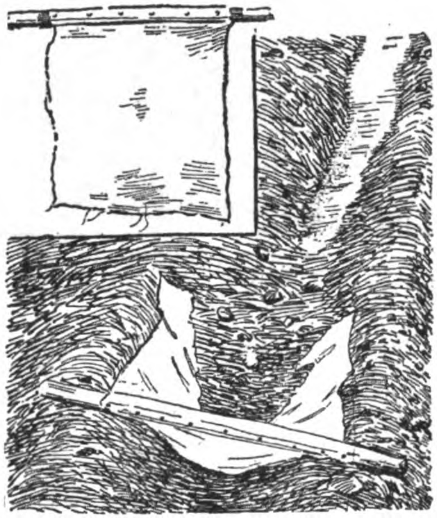


FIG. 380. A canvas dam in detail and in place. The water reaching it will be forced to overflow the ditch on the lower side.

must be very strongly built if the stream is very large.

**Ditch drops.** To lower the water in a ditch without serious erosion of the soil is a special problem on steep hillsides, and has been solved by the use of a series of wooden steps within a flume. At both ends of the flume, the sides are flaring to the width of the ditch, the step part of the flume being narrow to save lumber and to give strength to the construction. The flare at the discharge end must be sufficient to let the water out without great velocity into the lower ditch which, otherwise, would be deepened considerably at that point by the action of the water.

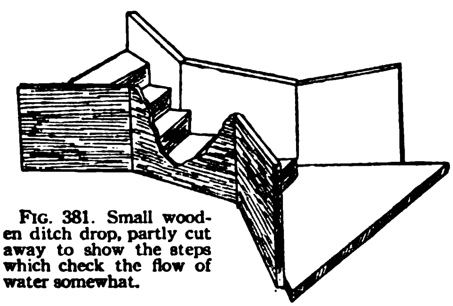


FIG. 381. Small wooden ditch drop, partly cut away to show the steps which check the flow of water somewhat.

**Division boxes.** Where the side branches or laterals join any main canal or ditch, the water is apt to wear away the corner of the outlet as it turns sharply from the direction of the canal to the lateral. At such places division boxes should be placed, the ditches lined with boards and regulating gates placed at each opening. The wooden flume should always extend a considerable distance down stream from the gate to provide for times when the gate is opened under a considerable head of water. Under these circumstances the water would rush with high velocity from the partially opened gate and very seriously affect any type of earth conditions.

**Water gates.** A single gate should be used wherever water is diverted or enters any canal of size. The construction should be permanent. A good type is a simple panel sliding vertically between strips on the inside of the flume. The gate should be loose, and directly above it there should be some construction to hold the gate up at varying openings. With gates of any considerable size, arrangements must be made for some mechanical device to aid in lifting them as the pull required on a gate having even 8 or 10 square feet exposed to a head of several feet of water is very considerable.

**Reservoir storage.** The importance of a regulating reservoir is not generally admitted. The necessity in irrigation where the supply of water is limited can be very well pointed out. In the case of a small spring making available only 2 quarts per second, saturating

FIG. 382. Rubble stone storage reservoir in pr cess of construction

the surface and being drained away by the subsoil, all the water it supplies may be readily taken up by the soil around about within 50 yards. By arresting this flow and accumulating it in a reservoir, there may be stored in 24 hours about 43,200 gallons of water, equivalent to one quart for each square foot over 4 acres; a week's storage would be sufficient to supply 12 acres with the equivalent of an inch of rainfall. This indicates clearly the importance of the conservation of water in every step of irrigation from the intake to the drainage canal. It also points out the reason for considering the use of drainage water from upper levels to be distributed on the lower fields. Every tiny stream is valuable in this type of work. Continuous flow is far more essential than volume in every phase of the work.

**Constructing ditches.** Large ditches are best made with the scraper, after plowing. The land is plowed deeply along the direction of the furrow so as to make it workable. The scraper is used across the direction of the ditch, starting on one side, traveling down the

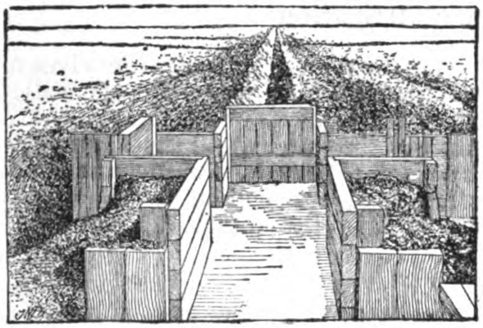


FIG. 383. Wooden division box used to divert the water from a main canal to a lateral without cutting away the banks. (Farmers' Bulletin 864.)

dip of the furrow and up the other side where the material is placed as an embankment. The depth of the ditches is usually made about one sixth the width, the depth being measured from the original surface of the land. Of course, the embankment adds considerably to the finished and usable depth of the ditch. A canal 10 feet wide is thus about 1½ feet deep at the centre below the original land level; a ditch 3 feet wide is perhaps 6 inches deep.

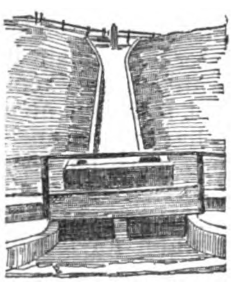


FIG. 383a. Long ditch drop passing under road in foreground.

The smaller ditches are often made directly with a listing plow having a double moldboard which throws the earth out on both sides. One or two passes usually gives depth enough. To finish such a ditch, an A-shaped scraper may be run through it. This scraper is made of two 2-inch planks fastened together at one end and braced apart at the other.

On a hillside, the ditches should be excavated in such a manner that all the earth is thrown out on the lower side; this is usually necessary in order to utilize the full cut.

## Drainage and Subirrigation

A method of subirrigation practised to some extent consists in laying tile with broken joints in a manner similar to that followed in drainage operations. Water is supplied to and leaks out through the joints for distribution. On the other hand, low lands and fields with a dense subsoil, yet requiring irrigation, frequently need proper underdrainage to keep the ground water level down and to prevent a surplus moisture supply from turning the fields into swamps. In laying tile for drainage or for subsurface irrigation, similar precaution must be taken with the

PRICES, WEIGHTS AND COST OF TILE LAYING:

| DIAMETER | PRICE PER 1,000 FT. | COST OF LAYING PER ROD 3 FT. DEEP | WEIGHT PER FT. POUNDS | AVERAGE CARLOAD |
|---|---|---|---|---|
| 4 inch | $ 22.00 | $0.36 | 6 | 6,500 ft. |
| 5 " | 32.00 | .36 | 8 | 5,000 " |
| 6 " | 43.00 | .36 | 11 | 4,000 " |
| 7 " | 55.00 | .38 | 14 | 3,000 " |
| 8 " | 75.00 | .44 | 18 | 2,400 " |
| 10 " | 100.00 | .50 | 25 | 1,600 " |
| 12 " | 150.00 | .55 | 33 | 1,000 " |

exception, perhaps, that in drainage operations, very special care must be taken in establishing and completing the grade or slope of the drains.

Subirrigation methods follow those of drainage except as to depth of laying. There are 4 distinct steps: (a) Laying out the direction and slope of lines; (b) digging the ditch; (c) laying the tile and making connections; (d) filling the ditch.

The first step should include making a sketch, however rough, of the job complete as planned. This sketch should be kept correctly, and as fast as any changes are decided upon, they should be plainly marked with distances and other data and filed for future reference as to the location of the lines.

The ditch can be dug with the plow, the depth being usually between 1 and 2 feet below the surface. The grade should be well established with the level and should not be more than 15 or 20 inches per 1,000 feet. The tile is laid in the ditch, with broken joints perhaps a quarter of an inch wide. Each joint can well be covered with a piece of stone or broken tile before the earth is carefully shoveled back and the ditch filled.

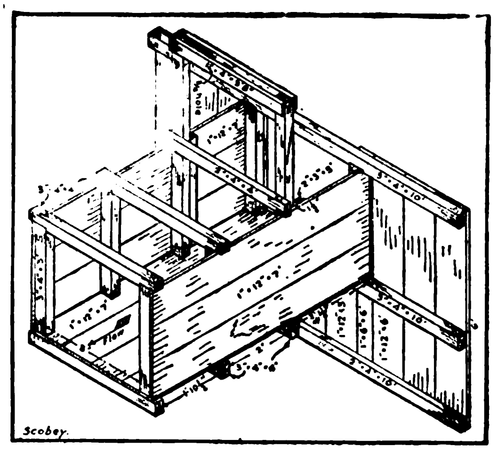
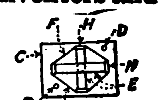



FIG. 384. Wooden water gate. Note apron at front end which is sunk in the soil to prevent excessive erosion. A smaller one should be affixed to the opposite end. (U. S. Dept. Agr. Bulletin 115.)

## Spray or Overhead Irrigation

The mechanical problem in applying water by the spray system involves a number of points, for example: (1) A minimum of labor; (2) breaking the water up into drops fine enough so that they will not injure plants or pack the soil; (3) uniformity of application; (4) perfect control of the water at all times; and (5) a minimum of expense for equipment. As a result of the efforts of inventors and manufacturers to achieve these ends, 3 distinct types of irrigation equipment have been developed—the nozzle line, the rotary sprinkler and the stationary sprinkler.



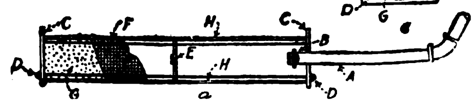


FIG. 386. Lengthwise section and (above) cross section of homemade strainer with which to obtain clean water for spray irrigation. A, suction pipe to pump; B, locknut to hold strainer on pipe; C, end pieces; D, iron brace rods and nuts; E, wooden braces to hold lengthwise bars (H); F, heavy galvanized wire screen tacked to H; G, perforated sheet brass tacked and soldered in place around wire netting.

The first consideration in irrigation equipment is, of course, the water supply. This is most commonly a running stream. In using this source of supply, the first step is to provide means by which to make sure that the water, before it gets into the main supply line, is free from sand, mud, or other impurities which might clog up the system. There are strainers in the pipes at the beginning of each distribution line, but these can be counted upon to take out only a comparatively small amount of impurities; otherwise they would themselves clog up so quickly as to require frequent cleaning. The most convenient way of cleaning the water is to strain it at the source of supply. A fine perforated brass "foot strainer," may be used, but this has not sufficient area under most conditions, and consequently has to be cleaned too frequently. An inexpensive strainer may be constructed easily as shown in Fig. 386. If a small stream is to be used, it will probably be necessary to dam it and to make a reservoir to store the water for use in drought periods. Even if the flow of the stream is sufficient to furnish the water required to supply the crops for, say, a week's time, it may not be sufficient to keep up with the demands when the system is in operation. The water reserve should be big enough to supply the pump at full capacity for 8 or 10 hours' run. If water is scarce, it may be necessary to put in a concrete reservoir that will prevent waste by leakage and drainage.

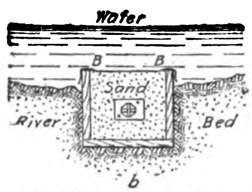



FIG. 385. Increasing the efficiency of a strainer by sinking it in a wooden or concrete box of sand and covering with a sheet of canvas or burlap (B B).

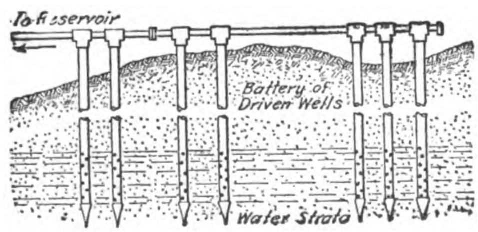



FIG. 387. How a battery of driven wells may be connected up to provide an increased supply of water

Fig. 385 shows a method of straining the water by the use of sand in addition to the wire strainer. This may be necessary in shallow streams with fine sediment or slime on the bottom. From ponds, it is usually not so difficult to get a supply of water already clean enough to use. The water from driven artesian wells is usually clean. Water from a battery of shallow driven wells which would not be sufficient to meet the pumping capacity of the plant may be collected and stored in a reservoir at a slightly lower level. (Fig. 387.) Or water may be lifted by a ram and stored in a cistern or tank of suitable size for use when needed.

## Water Pressure

To operate successfully any one of the systems of overhead irrigation the water should be under considerable head or pressure, from 30 to 60 pounds per square inch for the nozzle line type, and 20 to 80 pounds for the spray and rotary sprinklers, according to conditions. The amount of water which will be required should be accurately figured out, as this will form the basis upon which to determine the size of the main supply line and the capacity of pump and engine or tank and elevation as the case may be. If water will be required once a week at the driest season, the pumping outfit should be capable of supplying water for about one-fifth of the total area to be irrigated every working day.

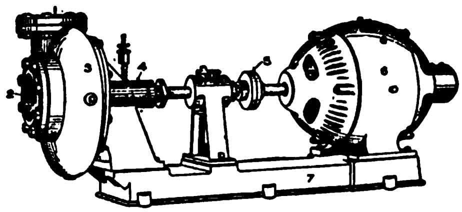


FIG. 388. A centrifugal pump connected directly to an electric motor is efficient and inexpensive for lifts of less than forty feet. 1, Discharge pipe; 2, suction pipe; 3, pump case; 4, stuffing box; 5, coupling; 6, motor; 7, base.

Where conditions are such that a reservoir or tank can be established without much cost, it may be cheaper to install a ram to elevate the water automatically rather than to put in a pumping outfit. Usually, however, it is not possible to get sufficient elevation without going too far from the tract to be irrigated. One may estimate roughly on a little less than half a pound pressure for every foot of elevation or fall—that is the difference, in a vertical line, between the tract to be irrigated and the water supply.

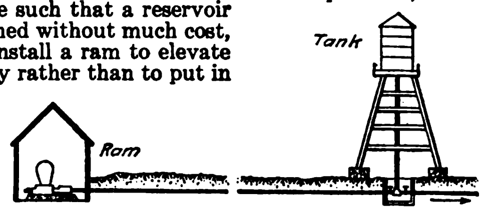



FIG. 389. A ram and elevated storage tank can be used to get the necessary pressure

For systems of moderate size— requiring up to 100 gallons or so per minute for all the lines it will be necessary to operate at one time, the one-cylinder, double-action pump, with a good capacity air chamber, will usually be the most satisfactory. The importance of the air chamber is that it equalizes the pulsations or variations in the water pressure between strokes, so that practically an even pressure is maintained. A centrifugal pump may be used where conditions are suitable; it costs considerably less for the same capacity. Either type of pump used may be either belt or gear driven, or connected direct to the engine. However, when the double-action pump is geared direct, there should be a check valve or by-pass set to open at a suitable pressure so that if all lines are turned off, or if anything happens to check the system while the pump is in operation, there will be no breakage in the machinery. There should also be a check valve in the main line just above the pump to hold the water between the times when the system is in operation, and a foot valve on the suction pipe, or some other convenient arrangement for priming the pump when starting it.

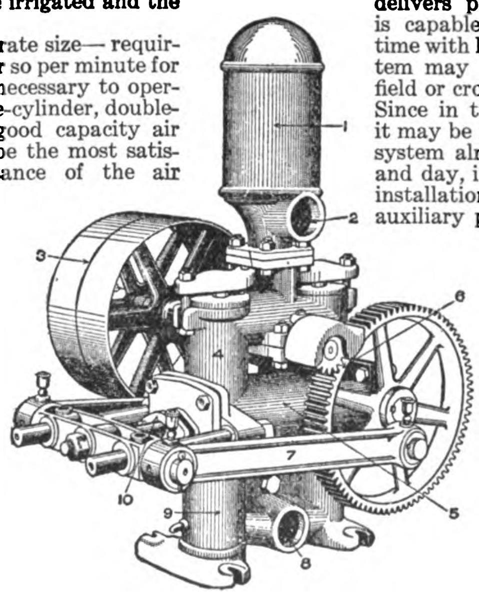


FIG. 390. A double-acting displacement pump is the preferred type for irrigating a few acres under average conditions. 1, Air chamber; 2, discharge; 3, light and loose pulleys; 4, valve chamber; 5, cylinder; 6, gear; 7, connecting rod; 8, suction opening; 9 base; 10, packing gland. (U. S. Dept. Agr. Bulletin 495.)

**Pump.** The type of engine used is not material, but it should, of course, be one that delivers power economically and is capable of running for a long time with little attention, for a system may be in operation on one field or crop for from 1 to 12 hours. Since in times of severe drought, it may be necessary to operate the system almost continuously night and day, it is always advisable in installations of any size to have an auxiliary pumping outfit that can handle at least part of the work if anything happens to the main pump. Many installations have both a gas engine and an electric motor; where a system is extended and a larger pump put in, the old one is usually kept as an auxiliary.

**Main or supply pipes.** The next consideration, is, of course, the distribution of the water to the field or fields where it is wanted for use. The system of mains or supply pipes should be worked out carefully so that the small-

est possible amount of the larger sized pipes need be used; at the same time, sufficient water and pressure at every point where it is wanted must be assured. Table, below, gives the amounts of water carried in different sizes of pipes.

There should be an expansion joint in the main line to take care of expansion and contraction of pipe as a result of temperature changes.

If there is much sand or sediment in the water, in spite of the strainer at the source, there should also be a "trap" or "bucket strainer" in the main line. Of course, sharp angles and numerous bends should be avoided as much as possible as they greatly increase the friction of the water in the pipes. Unless the whole pipe line is down below danger of frost, it should be laid to a slight grade so that it can be drained out clean in the fall at convenient points. Of course, the size of the main line may be decreased as branches or laterals for irrigating are taken off it. Valves should be placed wherever there are branches and at other convenient points for controlling the water.

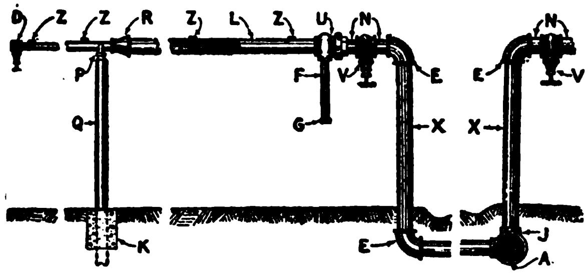


FIG. 392. Fittings for overhead nozzle line system: A, main feed line; D, drain cock; E, elbow; F, handle for turning nozzle line; G, capon handle; J, side outlet tee; K, concrete base for pipe pact; L, nozzle-line pipe; N, nipples; P, pipe hanger or support; Q, pipe post; R, reducing fixture; U, turning union; V, gate valve; X, risers to nozzle line; Z, nozzles.

## Equipment for Distribution

Each of the systems of spray irrigation—nozzle line stationary, and rotary sprinkler—and each of their various modifications, requires a system of laterals or small-sized branch pipes running off from the main supply line at right anglés to feed the nozzles or sprinklers that distribute the water over the soil.

Laterals. In the nozzle line type, these lateral lines must be above the soil. They are placed at from a few inches to 10 feet or so above the ground; the usual height is 6 to 7 feet. The laterals for the sprinkler types may be placed either above or below the ground. Usually they are put below, because this plan is easier and keeps the pipes more out of the way. Vertical pipes or risers are distributed at the proper intervals, and at the tops of these the sprinklers are placed.

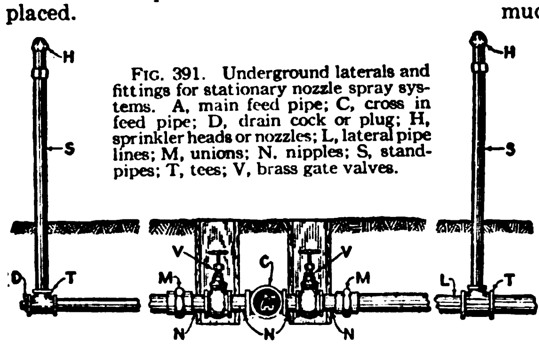


FIG. 391. Underground laterals and fittings for stationary nozzle spray systems. A, main feed pipe; C, cross in feed pipe; D, drain cock or plug; H, sprinkler heads or nozzles; L, lateral pipe lines; M, unions; N, nipples; S, standpipes; T, tees; V, brass gate valves.

The standard distance between the lateral lines for the nozzle line system is 50 feet. If water has to be used at less than 30 pounds pressure, they may be placed nearer than this; and under higher pressure they may be placed as far apart as 56 feet. The length of the nozzle lines may be anything that will suit conditions; 600 feet, however, has been found a desirable maximum length in large installations. The distributing nozzles are placed 2 to 4 feet apart along the nozzle line; 3 feet is the standard distance.

TABLE 1—AMOUNT OF WATER FOR SPRAY IRRIGATION DIFFERENT SIZES OF STRAIGHT IRON PIPE WILL CARRY WITHOUT EXCESSIVE FRICTION

| DIAMETER OF PIPE | QUANTITY PER MINUTE | DIAMETER OF PIPE | QUANTITY PER MINUTE |
|---|---|---|---|
| | Gallons | | Gallons |
| ½ inch . . | 1 to 2 | 3 inches . | 75 to 125 |
| ¾ inch . . | 3 to 4 | 3½ inches. | 125 to 175 |
| 1 inch . . | 5 to 8 | 4 inches . | 175 to 250 |
| 1¼ inches . | 9 to 16 | 5 inches . | 250 to 400 |
| 1½ inches . | 17 to 25 | 6 inches . | 400 to 600 |
| 2 inches . | 25 to 45 | 7 inches . | 600 to 900 |
| 2½ inches . | 45 to 75 | 8 inches . | 900 to 1,200 |

The nozzle line may be either supported upon posts or suspended from overhead cables. The latter system leaves the ground much clearer for working, there being only a few posts to the acre; but it is, of course, more expensive. For commercial installations, either cedar posts or second hand iron pipe posts set in concrete are usually used. The supporting posts are set at intervals of 15 to 20 feet according to the size of the pipe used for the nozzle line (see Table 2, p. 257). To facilitate the turning of long nozzle lines, roller-bearings or other supports are set on top of the posts or suspended from overhead cables.

Usually a valve is placed on each lateral near the main feed pipe so that its flow can be controlled as a unit. In

TABLE 2—SIZES OF PIPE FOR MAIN SUPPLY LINE

| FLOW (GALS. PER MIN.) | LENGTH OF LINE IN FEET | | | | |
|---|---|---|---|---|---|
| | 50 | 100 | 200 | 400 | 600 |
| 30 . . . . | 1½ | 2 | 2 | 2½ | 2½ |
| 75 . . . . | 2 | 2½ | 2½ | 3 | 3 |
| 100 . . . . | 2½ | 2½ | 3 | 3 | 3½ |
| 200 . . . . | 3 | 3½ | 3½ | 4 | 4 |
| 300 . . . . | 3½ | 3½ | 4 | 4 | 5 |
| 500 . . . . | 4 | 5 | 5 | 6 | 6 |

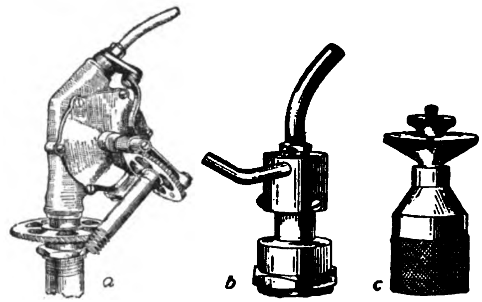



FIG. 394. Three types of sprinklers for the upright pipe system: *a* and *b*, rotary type; *c*, stationary, mist-producing type.

the nozzle line equipment, a device called a "turning union" (Fig. 393) is installed at the beginning of each nozzle line. This contains a strainer and has a hollow pipe handle to be used in turning the nozzle line from one side to the other. By removing the cap from this handle and turning the water on, loose scale, sand, etc., can be flushed out of the strainer chambers.

TABLE 3—SIZES OF PIPE FOR NOZZLE LINES WITH NOZZLES 4 FEET APART. IF CLOSER, LARGER PIPE IS REQUIRED

| NOZZLE | LENGTH OF LINE FEET | NUMBER OF FEET OF PIPE | | | | |
|---|---|---|---|---|---|---|
| | | ¾-IN. | 1-IN. | 1¼-IN. | 1½-IN. | 2-IN. |
| No. 1 4 Feet Apart | 150 | 150 | | | | |
| | 200 | 130 | 70 | | | |
| | 250 | 100 | 150 | | | |
| | 300 | 100 | 150 | 50 | | |
| | 400 | 90 | 160 | 150 | | |
| | 500 | 90 | 160 | 150 | 100 | |
| | 600 | 90 | 160 | 175 | 175 | |
| | 700 | 90 | 160 | 175 | 175 | 100 |
| No. 2 4 Feet Apart or No. 1 3 Feet Apart | 150 | 115 | 35 | | | |
| | 200 | 100 | 100 | | | |
| | 250 | 90 | 100 | 60 | | |
| | 300 | 90 | 100 | 110 | | |
| | 400 | 80 | 100 | 120 | 100 | |
| | 500 | 75 | 100 | 120 | 120 | 85 |
| | 600 | 75 | 100 | 120 | 120 | 185 |

With the rotary sprinkler type of irrigation, where the individual sprinkler covers a large area—that is, a circle 35 to 90 feet in diameter—the price of the equipment may be lessened considerably by getting only as many sprinklers as may be operated by the system at one time. By having caps on the risers, these sprinklers may be changed from one section of the field to another, wherever most needed. While this cuts down the cost of installation it means, of course, some additional expense in operation.

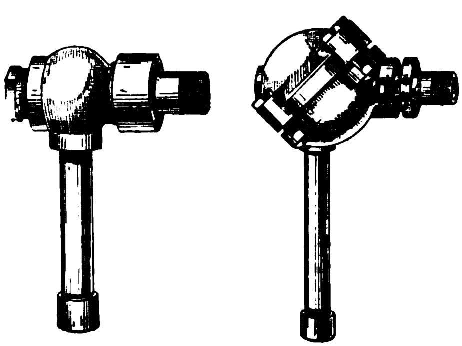


FIG. 393. Two types of handles for turning the nozzle pipe lines

## Portable Sprinkler Systems

In small gardens, and for the occasional irrigation of field crops during extreme drought, it is often desirable to irrigate, although a permanent installation would be objectionable or would involve too heavy an investment. The nozzle line systems may be bought in portable form as complete assembled units. By the use of special lever couplings, it is possible to put a nozzle line system up in sections so that it can readily be dismantled and re-assembled in exactly the right positions. Portable posts may be used or short temporary posts may be driven in the field. An extension to the main pipe line can be made either under ground or, if wanted only temporarily, by laying the pipe along the ground. With a sprinkler system, laterals and risers for the temporary work may be supplied and the sprinklers borrowed from the regular installation, or some additional ones may be kept on hand for this purpose. Temporary extended use of a system in this way, often means crop insurance, and as the pumping plant and main supply line

are already in use, it may frequently be accomplished at a very low cost per acre.

## Automatic Turning Devices

While small systems of the nozzle line type are usually operated by hand, it is possible to provide for the automatic operation of the system by mechanical turning devices. These are of two types: (1) a gear system operated by a belt from the pumping engine, and (2) a form of water motor or tilting device operated by the flow of water on its way to the distribution lines. The advantage of an automatic turning system of this kind is not merely in the saving of labor but also in the fact that the distribution is usually much more even than can be or, at least, usually is, obtained by hand turning. More water can be applied without saturating the surface of the soil, as the application at any particular point is more gradual.

TABLE NO. 4—SHOWING NUMBER OF GALLONS OF WATER REQUIRED TO COVER AN ACRE AND TIME REQUIRED TO APPLY THEM, USING THE STANDARD NOZZLES NOS. 1 AND 2, SPACED 4 x 54 FEET APART, OR 200 NOZZLES TO THE ACRE

NO. 1 NOZZLE

| POUNDS PRESSURE | | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FEET ELEVATION | | 23.1 | 34.7 | 46.2 | 57.8 | 69.3 | 80.9 | 94.2 | 104 | 115.5 | |
| One Acre 1-inch Deep | 27,152 Gal. | 18 | 15 | 13 | 11 | 10 | 9 | 9 | 8 | 8 | Hours |
| | | 51 | 17 | 18 | 54 | 52 | 42 | 23 | 54 | 26 | Min. |
| One Acre ½-inch Deep | 13,576 Gal. | 9 | 7 | 6 | 5 | 5 | 4 | 4 | 4 | 4 | Hours |
| | | 26 | 39 | 39 | 57 | 26 | 51 | 42 | 27 | 13 | Min. |

NO. 2 NOZZLE

| POUND PRESSURE | | 10 | 15 | 20 | 25 | 30 | 35 | 40 | 45 | 50 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| FEET ELEVATION | | 23.1 | 34.7 | 46.2 | 57.8 | 69.3 | 80.9 | 94.2 | 104 | 115.5 | |
| One Acre 1-inch Deep | 27,152 Gal. | 15 | 12 | 10 | 9 | 8 | 8 | 7 | 7 | 6 | Hours |
| | | 18 | 26 | 49 | 40 | 50 | 10 | 37 | 12 | 51 | Min. |
| One Acre ½-inch Deep | 13,576 Gal. | 7 | 6 | 5 | 4 | 4 | 4 | 3 | 3 | 3 | Hours |
| | | 39 | 13 | 25 | 50 | 25 | 5 | 48 | 36 | 26 | Min. |

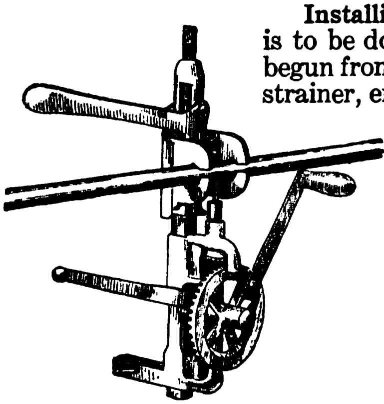
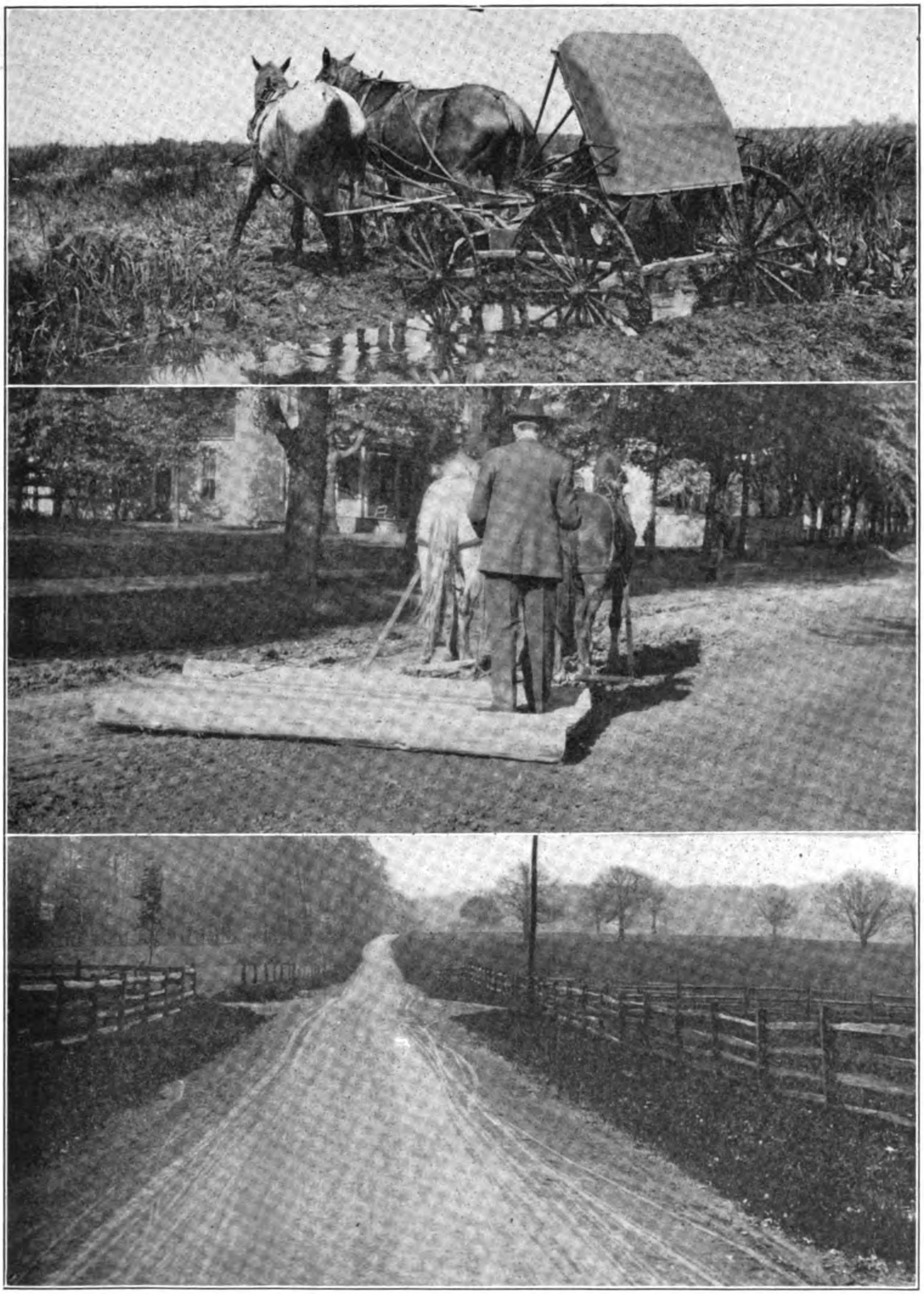


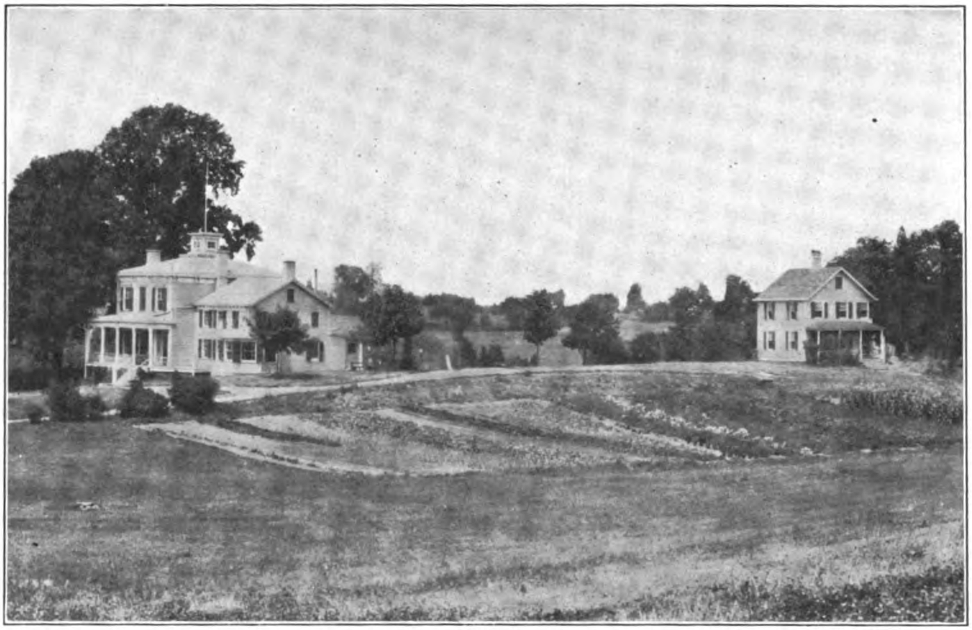
FIG. 395. Hand drill for boring nozzle holes in horizontal pipe line. These must be in a perfectly straight line and of uniform size.

**Installing a system.** If the work of installing a system is to be done in a hurry—as frequently occurs—it may be begun from both ends. However, the installation of pump, strainer, engine and so forth, usually represents the longest part of the job and should be attacked first. Second, the main supply line into the various fields should be assembled and put into permanent position, care being taken to knock off scale, etc., on each length of pipe before it is put in place, and to use red lead (on the thread ends of the lines only) in making up the joints. The main pipe should be so distributed through the various fields that the nozzle lines, as suggested above, will not be over 600 feet in length. These and risers for the nozzle lines being put in place, the exact positions for the lines of post may be deter-

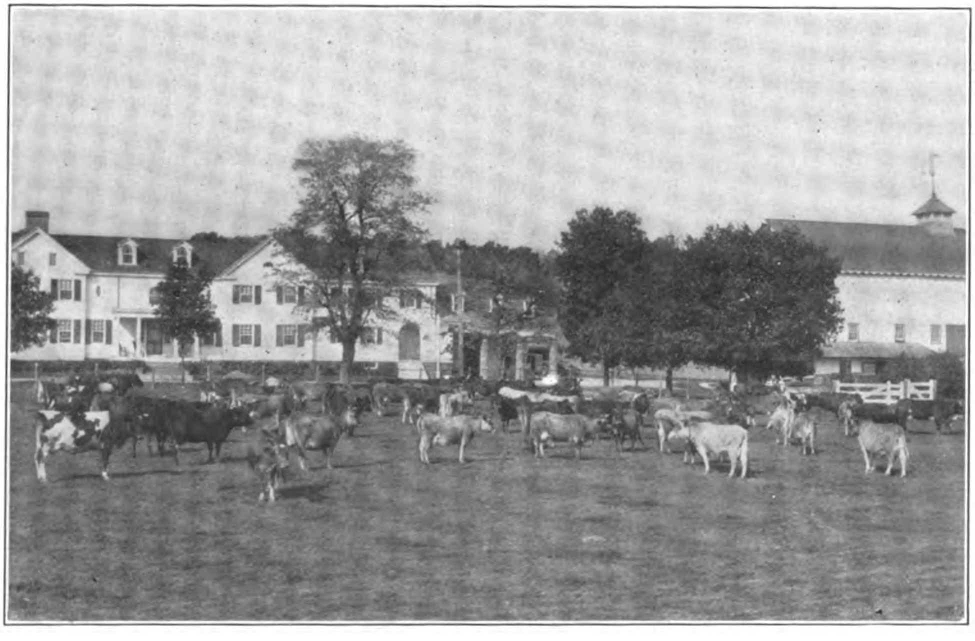


*Above*, the problem; *in the centre*, the solution; *below*, the problem solved

POOR ROADS ARE AMONG THE COMMONEST CAUSES OF FARM FAILURE. BUT THEIR IMPROVEMENT IS LARGELY IN THE FARMER'S HANDS



The farmhouse needs light, air, shade, and protection; so does the garden. Note how the needs are here supplied for both



The farm should centre around its main feature. Here this is clearly the dairy herd

THE WELL-PLANNED FARMSTEAD PLACES ALL RELATED FIELDS AND BUILDINGS AS NEAR TOGETHER AS POSSIBLE AND THE DWELLING IN A CONVENIENT LOCATION WITH RESPECT TO ALL OF THEM

mined and the posts put in place. The nozzle lines themselves may now be assembled, and drilled and tapped for the nozzles. One of the most important points in the installation is to make the holes for the nozzles at regular intervals and in an *exact, straight line,* along the shell of the pipe. Otherwise the distribution of water will not be even. This alignment is accomplished by the use of a special drilling machine, so constructed that it can be clamped to the pipe rigidly, the exact position wanted being determined by a small spirit level. A special drill bores the holes and threads or taps them at one operation so that the nozzles can be put in quite rapidly.

Before inserting the nozzles the pump should be run for a while, with the ends of all nozzle lines *open,* to allow the dirt, scale, etc., which may have accumulated in the pipe, to be washed out.

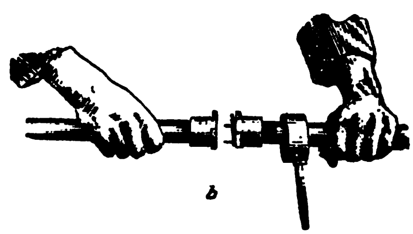



FIG. 396. Nozzles in different lengths of pipe line *must* be kept in line; and the way to accomplish this is by means of pins and socket holes in the unions of such sections.

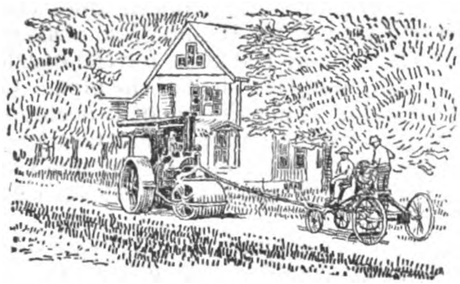


FIG. 397. The farm (like the community) that makes good roads and cares for them, soon pays their cost out of its increased profits.

CHAPTER 24

# The Building and Care of Farm Roads

*By* CURTIS HILL, *City Engineer of Kansas City, Mo., since 1913, but, in spite of his urban activities, a man with the training and the experience that fit him to write of farm conditions. He was born and raised on a farm in Jackson County, Mo., attended school there and at Independence, then took the engineering course at the University of Missouri, following it with a year in the Engineering College of Cornell University. His wide practical experience has included railroad construction; the making of field surveys and estimates for canal work for the Government in New York; highway bridge erection around St. Louis; and the following official positions: With the city engineering department of St. Louis for 6 years, State Highway Engineer of Missouri for 6 years, and the position he now holds. He is a member of the American Society of Civil Engineers.*—EDITOR.

WHEN a good, hard-surfaced road runs by a farm, giving the farmer means of easy access to central points, such as railroad station, village, and church, and to neighbors, it is a further pleasure, comfort, and saving to have easy access from central points on the farm to this main traveled road. If it pays the farmer to have a good road passing the farm to town, will it not also pay, in some degree, to provide means *on* the farm to reach that main road with the same ease and the same sized loads that he can haul over it? A good road means cheaper transportation, whether it be a "through-the-farm" road or a main county road. The through-the-farm road is here discussed from the constructional point of view only.

Travel on these roads is comparatively light, and they do not call for the type of construction required on roads traveled by many vehicles per day. This applies not only to a farm road, but also to one over which several farmers travel, a side road for a small community, or a country lane. Such a road must be simple in construction and inexpensive. A few farms may need a higher class of road; but the ordinary driveway, as herein outlined, will answer every purpose for the great mass of farms. Furthermore, the limited financial ability of many farmers is a condition to consider. The higher principles of road building, which is a science, are left for application to the main roads and to other roads which many vehicles use and where the demand is for a better and more costly construction.

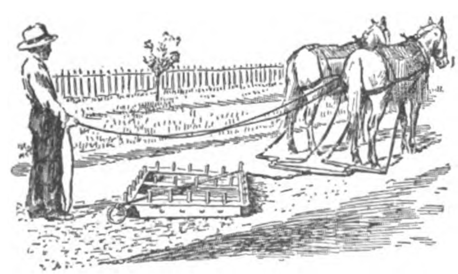


FIG. 398. Scratching up the surface of a road with a heavy spike-tooth harrow in readiness for a new surfacing and rolling.

**Kind of road and how to choose it.** The first step in building a road is to

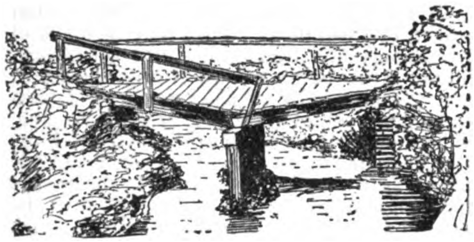


FIG. 399. This kind of bridge looks bad and is dangerous; it hurts the farmer's pride, his reputation and his pocket book and may do him serious personal injury.

study the local conditions and to choose the methods, plans, and materials most suitable to the needs and purpose for which the road is to be built. No one method, plan, or material will be equally adaptable in all places, but must be varied to suit local conditions. Use should be made of the natural material, placed in a way to give good results. For example, shale or slate will not wear well in contact with wheels, while gravel will. If there is a local supply of shale and but little gravel, the base of the roadbed may be made of shale and the surface of gravel.

Therefore, the determination of the kind of road to build, the width and thickness of roadbed, and the kind of material, depend upon the demands of travel to be made upon the road, the means for construction, and the accessibility of material. Local conditions should always govern, whether use is to be made of natural material as found or of artificial material, that is, natural material broken up or treated. One section may not have material, the best use must then be made of earth; in another, straw, sawdust, or sand may be mixed with clay or gumbo; in still another, shale or slate may be used to advantage. In some sections of the country, near the coast, shells are obtainable from which the road may be made; in others, there are banks, or ridges, composed of a chert-bearing soil which packs hard and becomes watertight under the pressure of travel, and here the chert road prevails. A special feature in many places is the gravel or the broken-rock road. So that, depending upon local conditions, we may have a farm road of any of the following materials: earth, straw, sawdust, or sand with earth, clay, or gumbo; shale; slate; chert; gravel; rock or other prevailing material.

Equally with the character of the road, the cost of building, also, will depend upon local conditions, upon the nearness and quality of material, width and thickness of roadbed, price of labor and teams, location, and topography.

## Drainage

The three principal divisions of actual road making are location, construction, and maintenance. With the exception of drainage, all details pertain to one or other of these. Drainage is involved in all three. The all-imperative, dominant, and paramount question is that of good drainage. If there is not good natural drainage, an effective system of artificial drainage must be installed; for, if the drainage be not good, the road will not be good. Drainage may be conveniently discussed under two heads: (1) surface drains, and (2) underdrains.

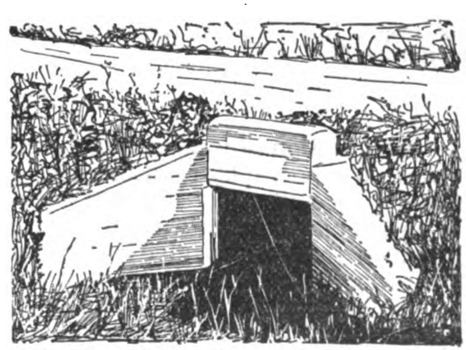


FIG. 400. This kind of culvert is easy and cheap to build; once built it is permanently safe, efficient and attractive.

**Surface drains.** Surface drains are the open ones, as crowns, ditches, and culverts. The object of the crown is to make a drained roadway for the travel and to get the water quickly off this traveled roadway into the side ditches. Make the side ditches to drain entirely off the rights-of-way at every opportunity. Where a ditch must cross the road,

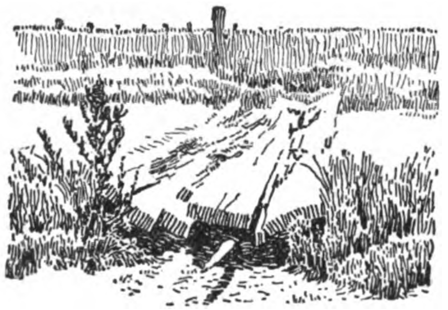


FIG. 401. Every time a farmer drives over an eye-sore like this without deciding to fix it—*and then doing so*, he goes one step lower along the road of carelessness, inefficiency and failure.

take it under the roadbed and not over it, and keep it on the side of the road and not down the middle of it. Side ditches are also made to protect the roadbed from water from adjoining lands; therefore, if the road be on a hillside, have a ditch on the upper side of the road. Culverts are of sufficient importance to constitute a subject in themselves. The cheapest in first cost are not always the inexpensive; for, as a general rule, the weaker the structures, the greater will be the cost for repairs and maintenance. There are some exceptions—where ready money is not available and plenty of timber is—where the wooden culvert is best; but one of metal, clay tile, stone, or concrete masonry is more often the economical construction.

Make the culverts long enough and with good head walls and wing walls, to throw the water into the barrel of the culvert and to prevent it from getting through the road alongside of the culvert or from washing out the fill and sides of the road. A good rule-of-thumb method to determine the size of opening is "1 square foot area in opening of culvert for every 5 acres of drainage area." This rule may be varied for a smaller culvert area, if the country is flat and the flow sluggish, and may be increased where the hills are steep, with much fall to the branch and a rapid run-off.

**Underdrains.** Underdrains are constructed from 2 to 4 feet deep. They may be made of buried logs; of a trench half-filled with stone, hay or straw being thrown in over the stone, and the remainder of the trench filled with earth or gravel; or of clay tile or concrete pipe; in fact, of anything along or through which the water can find its way freely. They must be so placed as to cut off the underflow in the ground before it reaches the road surface—to take the ground water out of the roadbed. Roads which dry out slowly after a rain, or in the spring of the year, need underdrainage to carry out the water and dry them out more quickly. Wet-weather springs or "spouty" places often occur on hillsides, where the surface drainage is good; but they never dry out. Underdrainage is the proper treatment for such places. These drains may be made directly across the roadway or laid along under the centre or side, leading out into the side ditch or a culvert or to low ground on one side of the road.

The drainage question may be summed up as follows: The roadbed must be protected from water, water which comes up from beneath as well as that which falls from above; and, in order to have a good road, the water must be gotten *out*, *off*, and *away*—out of the road by means of the underdrains, off the road by means of the crown, and away from the road by means of the ditches.

FIG. 402. Stone dam in a surface road drainage ditch, built to stop the flow of water and direct it through the culvert. Water should always cross a road *below* the surface.

## Location

The question of location enters more largely into consideration in a country of broken topography than in a level section. Where the position is not determined by the nature of the farm improvements, the choice of a suitable location for a road may eliminate a culvert, provide a good creek crossing or a good foundation for the roadbed, give good drainage, provide sunshine and air for the roadbed, lower the construction cost, or reduce the grades.

The reduction of grades (not grading) is a very important matter. One can afford to go around a hill, rather than over it, with a loaded wagon. Very often "the longest way round is the shortest way home." The term "grade" is not the cut, or fill, but is the rise and fall in vertical feet in each 100 feet in horizontal

| PER CENT OF GRADE | POUNDS WHICH A TEAM CAN HAUL |
|---|---|
| 0 per cent, or level | 4,000 |
| 1 " " " 1 foot in 100 feet | 3,600 |
| 2 " " " 2 feet " " " | 3,240 |
| 3 " " " 3 " " " " | 2,880 |
| 4 " " " 4 " " " " | 2,160 |
| 5 " " " 5 " " " " | 1,600 |
| 10 " " " 10 " " " " | 1,000 |

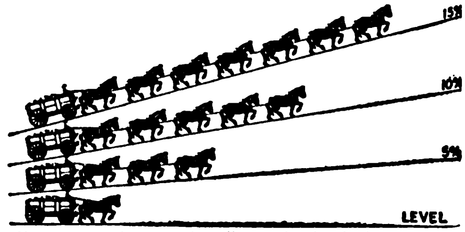


FIG. 403. How grade affects the load that can be hauled. This is on a smooth, hard road; on dirt the ratio is slightly less. Thus what one horse could pull on a level country road, would take two on a 5-per-cent, three on a 10-per-cent, and four on a 15-per-cent grade. (International Harvester Co.)

length of road. This is spoken of as the "percentage of grade" and is based on the 100-foot length. Therefore, a 2-per-cent grade is one of 2 feet rise or fall in each 100-foot length. A 5-per-cent grade (up) is a rise of 5 feet in 100 feet, or 25 feet rise in 500 feet. The accompanying table shows the importance of a grade (steepness) to traffic and the additional force, or pull, required by a team on different grades.

## Construction

Under the head of construction is included the work of actually building the road, such as grading, ditching, culverting, hauling, and placing the material.

The farmer, of course, is more or less confined to the class of tools and implements available on his farm; but, if he has much road work, he will save both time and money by obtaining those best suited for the work. If he has chert or other hard-compacted soil to loosen and haul to place on the road, he will find the "rooter plow" the best implement. Gravel may be sorted with forks made for the purpose, and a manure spreader may be used for spreading sand. In grading work, allowance should be made for shrinkage. Usually about 10 per cent is added to the height, so that the correct height will obtain after the fill has settled. The side slopes should be given the natural slope, about $1\frac{1}{2}$ horizontal to 1 vertical for earth, clay, or gravel, and about 2 to 1 for light loamy, or light sandy, soils. The drag scraper is best for moving earth up to about 100-foot-length haul; wheel scrapers, from 100 to 1,500 feet; and wagons, for greater distances. The regulation dump wagon or home-made slat-bottom wagon bed is suitable for hauling earth, gravel, and broken rock. A plow, a grader, a harrow, and a drag are necessary implements for shaping up and finishing the roadbed.


FIG. 404. Upkeep is as important as construction. This drainage tile will soon be washed bare and rendered useless.

**Earth roads.** Earth-road building consists in grading, draining, and shaping the ditches and roadbed (Fig. 405). The earth road must be drained and the surface become compact and solid before it is a good road. The supporting power of earth, when thoroughly wet, is only about one-fourth of that same earth when just sufficiently wet to pack without yielding. If the drainage, then, is properly attended to, the rest will follow.

Simple crowning and smoothing on all earth roads with grader and drag cost about 3 to 5 cents per cubic yard, or $30 to $60 per mile. When grading is to be done, moving earth, for the various hauls on the average road, costs about 20 cents per cubic yard.

**Sand-straw roads.** These should be kept rather flat, to retain some of the moisture in the road. The straw method of treating a sand road is to cover the traveled roadway to the desired width with 2 or 3 inches of woody straw, uniformly spread, and maintained by keeping the straw raked into the ruts. In some instances, the right of way outside the traveled roadbed has been planted with clover, rye, or some grass or grain having a woody

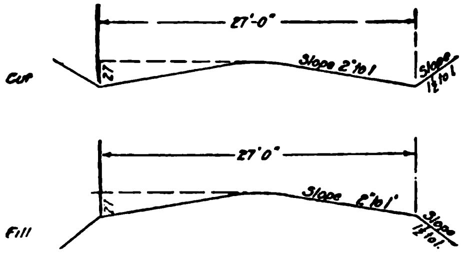


FIG. 405. Graded earth roads showing desirable relation between width and crown

fibered stem. This is cut and raked upon the centre strip of roadway each season. Sawdust (which is bad for an earth road) may be used instead of straw. The straw or sawdust treatment will help retain the moisture and in time will change the nature of the soil, making it firmer.

**Sand-clay roads.** The sand-clay road is one composed of a mixture of sand and clay. If, instead of clay, gumbo be used, the road may be termed a "sand-gumbo" one. Other kinds of cohesive soil of a plastic nature may be mixed with sand, to make a more compact and impervious roadbed. If the natural soil be sand, clay must be added; if clay, then sand must be added. The roadbed is prepared and shaped in the same manner as with an earth road (Fig. 405). The added material should be spread and mixed on the prepared roadbed with plow, harrow, disc and grader to the uniform thickness and width desired. All material dumped on the roadbed should be evenly spread as it is deposited. Each succeeding load should be hauled over the preceding one, after the first has been spread. The clay should be well pulverized and disintegrated and the materials mixed while comparatively dry. Enough clay, usually about one-third, must be used to fill the "voids" or interstices, of the sand. If there should be too great a proportion of one material, the opposite material must be added until the whole mixture shall be of the proper consistency. This may be done by hauling the opposite material from that of the natural roadbed or by adding the roadbed material by running the plow a little deeper or by bringing such material in from the sides or side ditches. The whole of the materials should then be mixed wet and puddled. Upon completion of the mixing, the roadbed should be reshaped and dragged while yet damp enough to pack well. If a roller be available, the roadbed should then be well rolled. No soft or uneven spots must remain, and the finished roadbed must present a true and even surface. It may not come up to expectancy at first; but keep going with the drag as you would on an earth road, adding such material as is needed, and it will ultimately make a good farm road.

The machinery required is a No. 10 plow, drag scrapers, disc harrow, spike-tooth harrow, road grader, drag, and 2 x 4 slat-bottomed wagon beds. With a mile haul for the added material and $1.75 for labor and $4 for teams, a 10-foot strip of sand-clay will cost about $1,000 per mile.

**Foundations.** Other kinds of road, now about to be discussed, require more or less preparation of subgrade or foundation to receive the material. A rock road, for example, is an earth foundation covered by a compact crust of small broken stone. The earth foundation supports this crust of broken stone as well as the loads which come upon it. This crust of rock placed upon an undrained, wet, or boggy earth will gradually work down into it until the wheels cut through. The foundation should be well drained, shaped, and compacted before it receives the wearing surface material.

After the drainage has been well provided for, excavate a trough-shaped section of the width and depth of the proposed road material. This trough should be crowned and shaped to the desired finish, that is, to conform to the proposed cross section without unevenness or soft spots and should be well compacted before the surfacing material is put on. If a roller is not available, let the subgrade become settled before adding the material. Where the material is to be put on an earth roadbed of approximately the desired shape, which is already firm and well compacted, it is better not to break up the old roadbed, since a solid subgrade, or foundation, is the thing desired. Put the material on this firm old roadbed, and draw in earth for the shoulders from the sides or ditches. This constitutes the first step. (See Figs. 408 and 411.)

In placing the material on this prepared foundation, spread it evenly by using a slat-

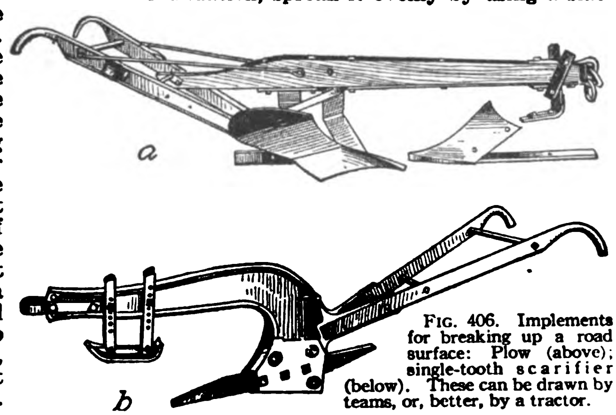


FIG. 406. Implements for breaking up a road surface: Plow (above); single-tooth scarifier (below). These can be drawn by teams, or, better, by a tractor.

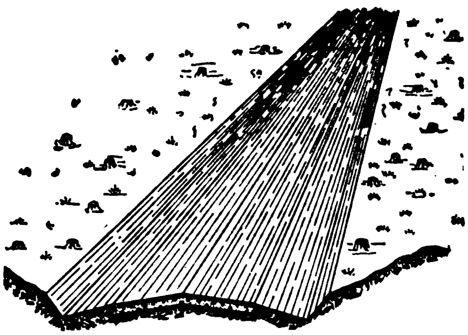


FIG. 407. Cross section of a road showing crown, ditches and relative location of foundation and surfacing.

bottomed, or dump, wagon and dump with the team slowly moving; otherwise, dump on a platform and shovel on to the roadbed, in order to spread the material evenly. If the material is dumped on the roadbed in a heap, it compacts more at that point than between the loads, and the road may settle in a wavelike surface. When dumping from wagons, dump the material where the wheel tracks will come and spread it each way; for the greatest wear upon a road falls within a strip under each wheel track, and the greatest compactness will then be on these lines. Let each load slightly overlap the preceding one.

**Shell, slate, shale, and chert roads.** In some of the coastal sections, where oyster shells are available and other materials are not, shell roads are built. The shells are spread evenly upon the prepared foundation, where they are compacted by the traffic. They are soon ground into a powder and blow or wash away, so do not make a lasting road, especially under heavy traffic.

Slate and shale roads are both inferior kinds, the materials grinding easily into dust and powder under traffic, or disintegrating from atmospheric conditions. The material is broken up and placed on the roadway in a manner similar to that described for shell roads.

Chert, to which reference has already been made, is also one of the inferior road-building materials, but is better than either shells, slate, or shale. It is placed in the same manner as the others, but wears and weathers better and also binds together and consolidates more effectively.

Other kinds of material of a quality equal to any thus far described may be found and utilized. It is not worth while to put the expense upon them required for a high-grade road. Any of them might be used for the base under a broken-rock or gravel road. (Fig. 409).

The cost of a road built from one of these materials for a 10-foot road will be about $800 to $1,000 per mile, exclusive of grading, but including shaping the roadbed and a haul of 1 mile for material.

**Gravel roads.** For gravel roads, the gravel should not run too unevenly (this can be governed by forking in loading), and should contain 15 to 25 per cent of fine material, to act as a filler for the gravel. A gravel which nature has packed and cemented in the bank, for example, often indicates the

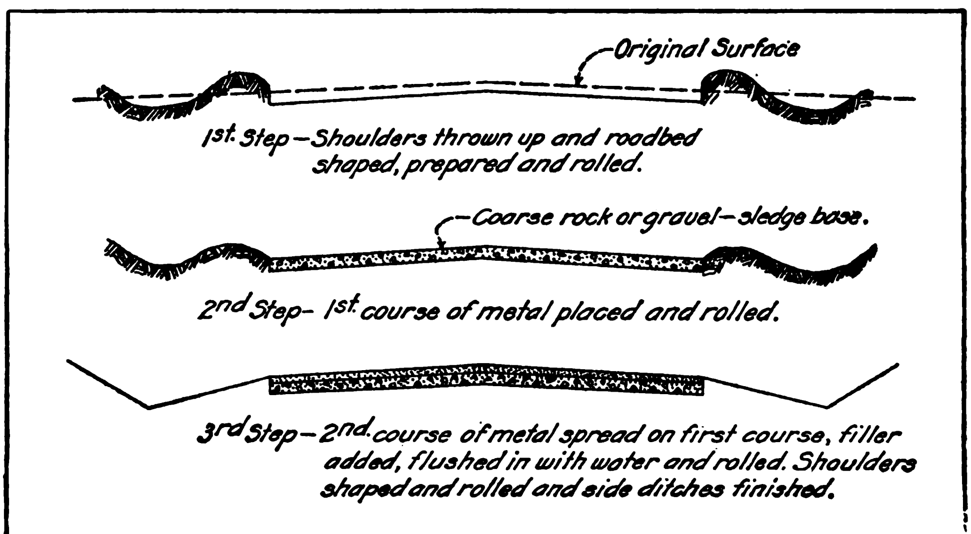



FIG. 408. Three steps in making a rock or gravel road of the higher grade or Class A type

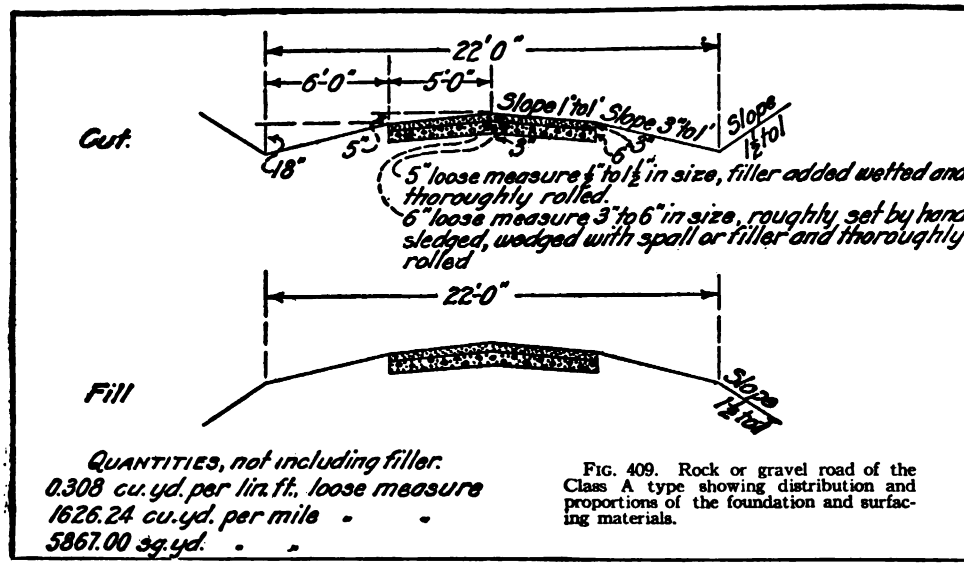



FIG. 409. Rock or gravel road of the Class A type showing distribution and proportions of the foundation and surfacing materials.

presence of lime, clay, or other cementing medium and will always recement in the roadbed. If it is a clean gravel, it is hard to consolidate without some smaller material, and this is called the "filler."

Gravel roads, like rock roads, may be divided into two classes: Class A, of the better class of construction; and Class B, of the cheaper kind (Figs. 410, 411). For a Class B road, the gravel should be placed on the prepared earth foundation and between the shoulders of earth thrown up from the side ditches to receive it. The gravel should not be larger than 3 inches, measured on the greatest dimension. One inch of filler, preferably limestone screenings, should be spread evenly over this, and the surface then well harrowed with a spike-tooth harrow (Fig. 398).

At the same time, the earth shoulders should be kept drawn up to the sides of the gravel, to hold it in place. This is the second step (Fig. 411). When the harrow has been passed over the surface a number of times, another inch of filler material should be spread over it, and the sides, shoulders, and ditches finished to the proper slopes and shape. Watering and rolling may be dispensed with, so that, with the addition of a grader, this class of road can be built with the ordinary farm implements. In some soils, a drag may be substituted for the grader.

Care should be taken to keep the ruts filled and the crown shaped up while travel is consolidating the newly finished road. As fast as ruts and low places are formed by the wheels of vehicles, gravel should be raked into them (the drag or harrow can take the place of hand work), and this work should be kept up until the roadbed is solid. Let nature do the sprinkling, travel do the rolling, and yourself do the dragging; and in a year's time the road will be pretty well consolidated.

The cost of a 10-foot gravel road for a 1-mile haul of gravel, exclusive of grading, will be about $1,000 a mile (Fig. 409).

**Rock roads.** Rock roads of Class B, or the cheaper road of rock is constructed in a manner similar to that described for a gravel road of the same class. Rock from the crusher, taking what is termed the "crusher run," is substituted for gravel, but, otherwise the details of gravel-road construction apply here also. The rock should be selected with a view to its hardness, toughness, and cementing value. Where, as is generally the case, there is but the one kind available, there is frequently a choice between the different ledges, between ledge and field rock or between solid and shell rocks.

The broken stone is spread on the roadbed to the required width and thickness. It should be broken to such size that no stone shall be larger than 3 inches, measured on the greatest dimension. It must be spread evenly upon the foundation, to present a true surface to the finished road. Stone screenings, or crushed rock less than one-fourth inch in size, or other suitable filler, should be spread over the surface and then be harrowed with a spike-tooth harrow as long as the teeth will penetrate the surface. Another inch of filler should then be evenly and uniformly spread over the surface, and the shoulders and ditches finished. The finished road should be given the same attention while consolidating under traffic as that described for gravel roads.

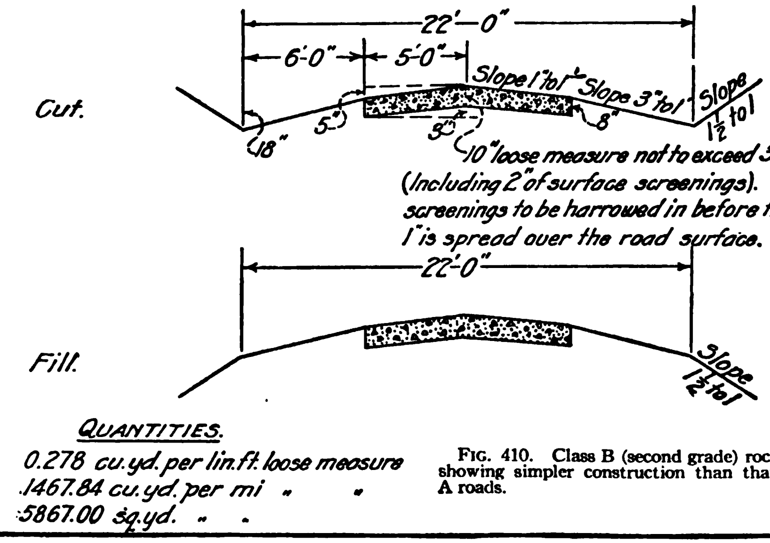



FIG. 410. Class B (second grade) rock or gravel road showing simpler construction than that used in Class A roads.

The cost of a rock road, exclusive of grading, calculated for a 1-mile haul of rock is about $1,500 for a 10-foot road (Figs. 410 and 411).

**Roads of higher grade.** The roads thus far described, and designated Class B, in which road metal is used, represent a kind of construction more often within reach of farmers for roads and farm lanes than the more expensive and better kind, which we have termed Class A. If duly cared for and properly maintained, they make good farm roads.

The construction of roads of the higher grade, or Class A, may be divided into 3 steps or stages: (1) the subgrade, or foundation; (2) the base, or first course of metal or hard road material; and (3) the wearing surface, or second course of metal. The material, or metal, is put on the prepared foundation in courses, usually 2, but never less, and neither course should exceed 8 inches in thickness, as the complete effect of the roller extends only through 6 or 8 inches. The lower course of material may be of an inferior quality to that of the top course. The interstices, or voids, of the stone or gravel should be filled with a suitable binder (preferably limestone screenings in water-bound construction) well dampened ahead of the roller. As the top course will be in contact with the wheels, it should be of a lasting and wearing quality; and water should be used to flush the filler into the voids, since road material will compact better damp than dry. The foundation should be shaped out, all soft spots removed and replaced with good earth and thoroughly and evenly rolled ahead of the material. Care must be taken to get the metal on evenly and uniformly and the whole well rolled. The crushed rock is separated into the required sizes by means of screens at the crusher, and care should be taken to see that the size is regular and within the specified limits.

**The subgrade, or foundation.** The complete subgrade should be of an even finish, shaped to a true surface, rolled until thoroughy compacted and with no soft or uneven spots remaining. This is the first step (Fig. 408).

Ditches should be excavated of such widths and depths as the drainage requirements demand, and with true grades and sufficient incline to furnish a free and uniform flow of water. Whenever necessary, subdrainage should also be provided.

A shoulder should be left when preparing the subgrade on each side of the roadbed, and be rolled with the final rolling. Rolling should be commenced at the sides and on the shoulders and, working toward the centre of the road, be continued until the material is well consolidated. All broken rock, screenings and filler should be spread evenly upon the roadbed.

**The base.** A layer of broken stone should be spread on the prepared subgrade to the desired width and thickness. The stone for this course must be broken to such size that no stone shall be less than 3 inches, nor larger than 6 inches. It should be placed upon the road to present a true surface to the finished road. Stone screenings, broken rock, and spalls should be sledged and worked into the crevices, making what is termed a "sledge" base, and the whole should be thoroughly rolled. This is the second step (Fig. 408).

**The wearing surface.** The second course

of stone, the wearing surface, should then be added. This is the third step (Fig. 408). This stone should be not less than one-half inch nor larger than 1½ inches. It should be evenly and uniformly spread and rolled to partial compactness, after which sufficient screenings (rock less than one-fourth inch in size) to fill all voids should be spread over the surface and flushed in with water. The whole should then be rolled until thoroughly compacted, further screenings and water being added during the rolling until the voids are thoroughly filled with screenings, and the surface becomes smooth and rounded, and no further compacting is possible. No material should be used which will produce mud or dust. Neither should clay or any sticky material be used, because when it is picked up by the wheels the fine surface rock will be picked up with it.

The same specifications will apply to this class of gravel road, as the former except that the gravel of the first course may run from 2 to 6 inches in size and contain from 20 to 30 per cent of filler (smaller than 2 inches) reasonably well distributed throughout the mass. The second course of gravel should be from half inch to 1½ inches in size and should contain from 20 to 30 per cent of material of less size. It is better if this last course of gravel does not contain the finer material and that limestone screenings to that extent be added, flushed in, and rolled. The finished rolling, watering, and shaping is the same as that indicated for a rock road.

**The telford road.** The telford road belongs in this class of construction and is one with a base course of heavy stone placed athwart the road.

The stone is broken to suitable size and set by hand with the broad end, or edge, down and in courses at right angles to the centre line of the road and firmly wedged by hand. All irregularities of the surface should be reduced with a hammer until no stone has a maximum projection or depression exceeding 2 inches, and the whole should then be thoroughly rolled. The crown to the base may either be formed in the foundation or may be made by using stone of increased depth toward the centre in the base. The rest of the construction is the same as that described for this class of regular rock or gravel road.

The cost of this class of road is nearly double that of Class B (Figs. 410 and 411), for the same width, length haul, and other conditions. The itemized cost for average country conditions is about as shown in the accompanying table.

| NATURE OF WORK | COST | |
|---|---|---|
| | PER SQ. YD. | PER CU. YD. (loose) |
| Quarry rent | $.013 | $ .05 |
| Quarrying | .100 | .40 |
| Crushing | .075 | .30 |
| Hauling (1 mile) | .075 | .30 |
| Shaping roadbed | .035 | .12 |
| Spreading material | .03 | .11 |
| Rolling | .015 | .06 |
| Sprinkling | .014 | .05 |
| Superintendence | .013 | .05 |
| Incidental | .015 | .06 |
| TOTAL | $.385 | $1.50 |

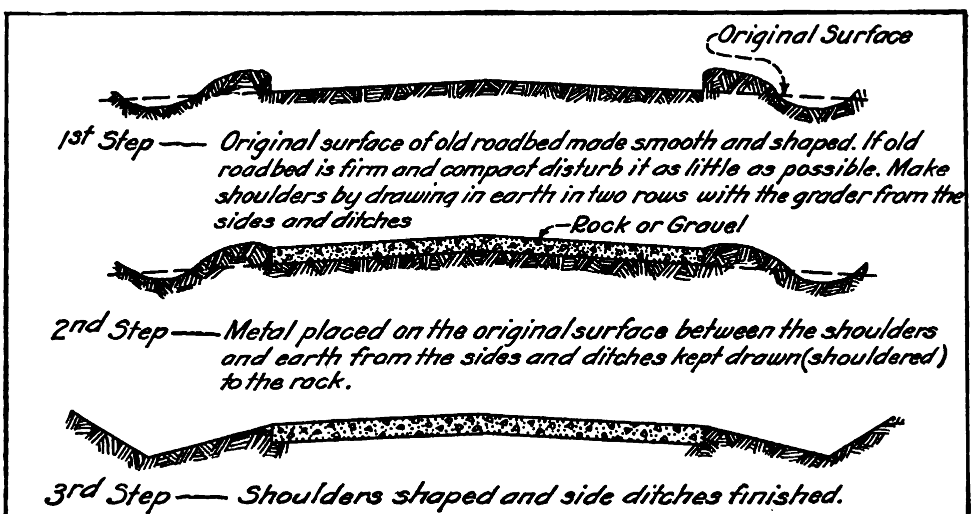



FIG. 411. Three steps in the making of a class B rock or gravel road

**Bitumen in road making.** The roads thus far described are of what is termed "water-bound construction." In these, water is a vehicle to carry the filling material into the voids, and also to dampen the material, so that it will be more firmly compacted. This construction depends more upon consolidating than upon cementing the particles together. In "bituminous-bound" roads, bitumen is substituted for water, to get a more tenacious cementing of the parts together. This bitumen is especially prepared for road purposes from tar, asphalt, or asphaltic oil. For construction purposes, it is generally applied in what is termed the "penetration method," which requires some changes in method of construction from any thus far described. In fact, a greater degree of care and slightly different methods are used to develop a still better class of roads than those hitherto described, in both water-bound and bituminous-bound types.

Concrete or brick might be recommended for some localities, but both of them, as a rule, are too costly for application to farm roads, country lanes, and side roads. If one intends to embark on this class of construction, he should employ a road expert.

**Sprinkling method.** Some use may be made of the "sprinkling" method. This consists simply of an application of road oil by sprinkling. It is principally a dust preventive, but anything which prevents the surface of a hard road from grinding into dust adds to the life of the road. When uniformly coating the stone, it forms a bond which prevents the rapid wear and disintegration of the roadbed surface. The surface of the road should be placed in good condition, cleaned of all foreign substances, and be perfectly dry, and the application of oil should be made in dry, warm weather. The oil is applied by means of a sprinkling wagon and allowed to penetrate to a depth of, usually, 1 or 2 inches. It may be applied to an earth surface as well as to one of rock. This method requires from one-fourth to one-third of a gallon of oil per square yard of surface per application with 1 or 2 applications per year, and costs about 2 cents per square yard.

**Earth-and-oil roads.** The ordinary method of constructing an earth-and-oil road is to plow and pulverize the earth about 4 inches deep. While applying the oil, the earth is cut, rolled, and turned with plow, disc harrow, and grader until it becomes well saturated with the oil. It is then ironed out, with a light roller. The oil and mixing can not be well done in 1 application of oil, but the oil is gradually applied while mixing. It takes about 2½ gallons per square yard of surface and will cost about 15 cents per square yard. Road oil of from 40 to 50 per cent asphalt is used. Oils of over 50 per cent asphalt are too heavy for this class of work, and will not penetrate unless heated.

## Maintenance

Traffic and the elements are continually tearing the roads down, so we must be continually building them up, A small hole soon becomes a large one, and a roadbed can be kept smooth only by constant care and attention. It is this constant care and attention in the proper use of the drag which makes this implement one of the best for maintaining earth roads. It is also a good maintenance tool for the sand-clay road and for some gravel roads (Fig. 413).

**Drags.** The King, or "split-log," drag (Fig. 412) is made from the 2 halves of a split log 10 or 12 inches in diameter and 8 or 10 feet long. The halves are fastened about 30 inches apart with strong 3-inch wooden dowels, or stakes, driven into 2-inch auger holes; and they are set with their flat sides to the front and staggered about 1 foot. Five or 6 feet of the ditch end of the front slab is faced with iron for a cutting edge. This iron face is 2 or 3 inches below the lower edge of the slab at the ditch and cutting end, and runs out flush with the lower edge of the slab at the other end. A plank platform, for the driver to stand on, is laid across the dowels. The long end of the hitch chain, 7 or 8 feet in length, is fastened over the top of the front slab and to the cross-stake, or dowel, at the spillway end of the drag. The short end of the hitch chain, about 3 or 4 feet long, is

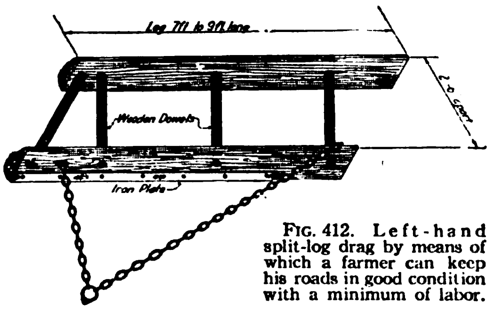



FIG. 412. Left-hand split-log drag by means of which a farmer can keep his roads in good condition with a minimum of labor.

passed through an auger hole near the centre line and from 6 to 8 inches from the end of the cutting, or ditch end of the front slab.

A plank drag (Fig. 413) is made in a similar manner, with 2 x 12 timber for each slab, reinforced by a 2 x 6 of the same length and bolted along the centre line to each 2 x 12.

The length of the hitch chain, slipping it backward and forward through the hole in the ditch end of the slab, regulates the hold taken on the earth. The position of the snatch hook to the doubletrees regulates the cutting effect. The shifting of his weight, or position, by the driver on the platform of the drag also regulates the cutting, carrying, and spilling effect of the drag. The drag is hauled at an angle of about 45 degrees with the line of the road.

The time to use the drag is when the road surface is moist, but not wet. The effect of the drag is to put on just enough soil to fill all holes, ruts, or hollows, pressing the water out of them and, by a smoothing and puddling effect, leaving the surface in better condition to sustain loads and shed rains. Some soils stick to the drag if too wet, others will stand wetter dragging. Different soils require different treatment. The rate of dragging should be about 1 round-1 mile-1 hour.

**Keep roadbed and side ditches clean.** On any kind of road, the sides between the traveled roadbed and the side ditches should be kept clean, so that the water may be shed freely to the ditches. The ditches and culverts, also, should be kept open and clear of obstructions. It is also a good principle of construction always to *repair a road with the same material of which it is made.*

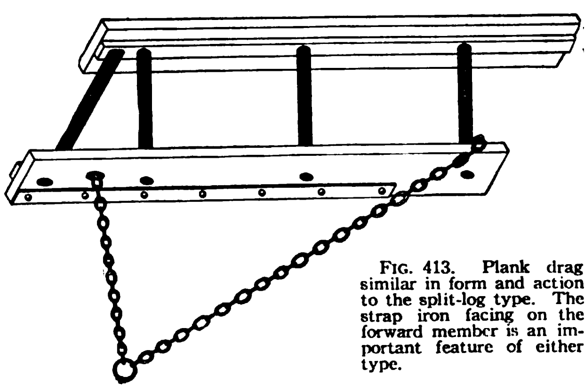


FIG. 413. Plank drag similar in form and action to the split-log type. The strap iron facing on the forward member is an important feature of either type.

Where ruts, holes, or defects appear in gravel, rock, or other hard-surfaced roads, use the hand rake to fill them with small loose stone raked in from the high points or the edges of the road. If additional material be needed, haul on small-sized stone and keep it raked into the defective places. On the better class of roads, the spot to be repaired is cleaned before depositing the material, and either tamped or rolled.

Defects and wearing away will develop in any road. Repairing these defects and replacing this loss *as soon as possible*, is maintenance.

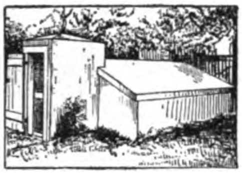


FIG. 414. Frostproof root cellar

# CHAPTER 25

# Concrete and Its Use on the Farm

FIG. 415. Substantial, fireproof farm garage.

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CONCRETE is an artificial stone. Its ingredients are portland cement, sand, pebbles or broken stone, and water. Portland cement, when combined with water, undergoes certain changes which make it harden; and in this hardening process the portland cement acts as a binder to unite the sand and pebbles or broken stone into a firm mass which, in the course of a comparatively short time, becomes very hard and eventually, is to all intents and purposes, stone.

**Portland cement.** Portland cement is a manufactured product. It was given the name "portland" because of a resemblance which the first manufactured cement when hardened, had in color, to stone quarried at Portland, England. The name, therefore, means nothing except that such cement is a manufactured one. There are so-called natural cements, but these are comparatively little used in building construction, and hereafter in this chapter, when cement is referred to, it should be understood that portland cement is meant.

Portland cement consists principally of limy and clayey materials. There are several other substances in cement, but their presence is due principally to the fact that they are contained in small quantities in such limy or clayey materials.

When the correct quantities of raw material for portland cement have been selected, they are burned in a kiln at a temperature which converts them into a sort of slag or clinker. This clinker is afterward ground in what are known as tube mills, these being large revolving steel drums partly filled with flintlike pebbles which are tumbled about as the drum revolves, thus reducing the clinker to a fine flourlike powder. This powder is portland cement.

Being a manufactured product, the quality of portland cement can be controlled with practically any degree of exactness required. Many persons are under the impression that portland cement varies greatly in quality. Some people refer to "good" portland cement and likewise to "bad" portland cement. Portland cement is made to meet specification requirements which have been found necessary to make it suited to the uses to which it is put; namely, to make mortar and concrete.

The only thing that can happen to portland cement to make it unfit for use is exposure to damp while in storage. Portland cement is purposely made sensitive to water. If it is stored where it can be affected by damp, it undergoes gradual and progressive hardening which will make it unfit for use. Therefore, portland cement, before use, should be stored in a tight, dry shed and piled on a board floor sufficiently above ground to prevent absorption of damp. If, when the sacks are opened, there are no lumps which cannot be crushed by light pressure between one's fingers, the cement has suffered no injury. If, however, there are lumps which require more than such light pressure to crush them, it is an indication that damp has acted upon the cement, and any such lumps should be discarded. Portland cement is now almost invariably shipped in cloth sacks or paper bags containing 94 pounds net. It is usually billed by the barrel, a barrel being figured as 4 sacks. Manufacturers and dealers make a charge for the cloth sacks, because, if they are taken care of and returned to the dealer or manufacturer in good condition, they will be redeemed for the price at which they were billed. Sacks should, therefore, be opened carefully and kept dry. Sacks which have been wetted or torn will not be redeemed.

**Aggregates.** "Aggregates" is the name given to the sand and pebbles or broken

stone which are combined with the portland cement in the manufacture of concrete.

**Sand.** Aggregates are referred to as "fine" and "coarse." Sand is called "fine aggregate." Not every kind of sand will do for concrete. Concrete sand must be graded from fine to coarse, and in such grading the volume of coarse particles should exceed the fine ones. Usually concrete sand should range from quarter-inch particles downward to the finest permissible ones, exclusive of dust.

Sometimes, stone screenings from hard rock, such as granite, are used in a concrete mixture in place of sand. They, also, must meet the same specifications; that is, they must range from quarter-inch downward in size and must be free from dust.

**Pebbles or broken stone.** Pebbles or broken stone are referred to as "coarse aggregate." By "pebbles" is meant coarse material ranging in size from quarter-inch up to 1 or 1½ inches or, in some cases, 3 inches, depending upon the kind of work for which the concrete is being made. The same specifications would apply to broken stone, when used as coarse aggregate instead of pebbles.

Many persons think that natural bank-run material, which is sand and pebbles as taken directly from a gravel pit, is just the same as properly graded sand and pebbles. This is not true, because in a concrete mixture it is very necessary that the materials be proportioned so that voids, or air spaces, will be reduced to the lowest possible minimum. This cannot be done without using an excess quantity of cement where natural bank-run gravel is used instead of definite volumes of sand and pebbles or broken stone. The reason for this will be made clear by the following: Practically every gravel pit contains twice as much fine material (sand) as coarse material (pebbles). In most concrete mixtures, proportions for which are given below, it will be seen that correct proportions involve a ratio between fine and coarse materials practically the reverse of the ratio between such materials which exists in the natural gravel bank. No matter how solidly the materials may seem to lie in the deposit, there are from 33⅓ to 45 per cent or more of voids or air spaces. This can be proved by taking from the pit enough material to fill a tight box having a capacity of 1 cubic foot, packing the material in the box as firmly as possible, and then pouring water into it until the box just overflows. An experiment of this kind will prove that, in addition to the compacted material from the gravel bank, there may be added to the box from one-third to nearly half its capacity of water. Bank-run material must, therefore, be screened so as to separate the fine material from the coarse to enable correct proportioning of the two when preparing a concrete mixture.

**Screening materials.** For screening bank-run material, a suitable screen may be made by building a frame from 2½ to 3 feet wide and 6 feet long from 2 by 6-inch lumber and nailing over this screen-wire netting having quarter-inch square meshes, or slotted screen wire having three-eighths inch slots with cross wires from 4 to 6 inches apart. When such a screen is set at an angle of about 45 degrees, and the bankrun material thrown at its upper end in shovelfuls, the material rolling down the face of screen will be separated into fine and coarse particles. It may be necessary to pass the coarse material over another

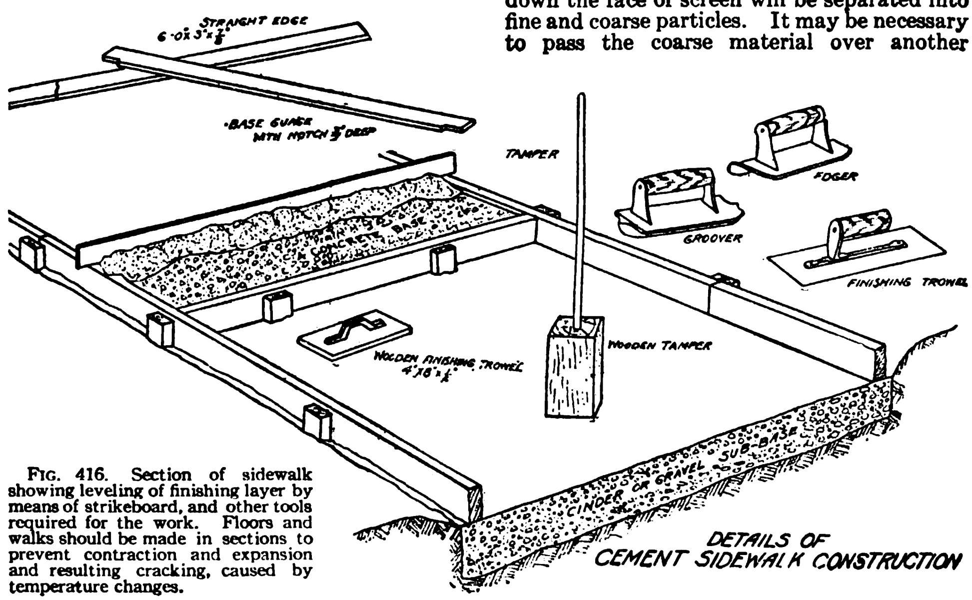



FIG. 416. Section of sidewalk showing leveling of finishing layer by means of strikeboard, and other tools required for the work. Floors and walks should be made in sections to prevent contraction and expansion and resulting cracking, caused by temperature changes.

screen having 1¼-inch or 1½-inch meshes, so as to exclude particles that would be too large. The maximum size of particles that can be used in any concrete mixture is governed entirely by the nature of the work. In reinforced concrete work, the largest particles should not exceed 1 inch in greatest diameter; otherwise, the concrete cannot be solidly compacted in the forms nor brought in intimate contact with the reinforcing material.

**Use clean materials.** Several things must be borne in mind when selecting aggregates for concrete making. The materials must be clean. They must be free from dust, loam, clay, or other foreign material. If there is much of such material present, it will prevent the cement from coming in contact with the surface of the aggregate particles, and this, in turn, will prevent the cement from acting as a binder to unite the mass. A very small quantity of foreign materials such as those mentioned, say, not more than 3 or 4 per cent, is not objectionable, if the concrete is thoroughly mixed. If foreign material is present in excess of 4 or 5 per cent, it must be removed by washing.

**Washing aggregates.** Small quantities of aggregates may readily be washed in an inclined trough by throwing them in at the upper end of the trough and introducing water there in sufficient quantity to cause the materials to roll down the trough. This tumbling about will loosen, or wash out, clay and loam which will be carried away by the water as it leaves the trough at the lower end. Such a trough may readily be arranged with a screen near its lower end, so that the sand and pebbles will be separated as well as washed. Another simple way of washing materials is to build a large tray, say, about 4 feet wide, 10 feet long, and 8 or 10 inches deep, prop up one end slightly, and throw the materials in at the higher end. Then apply water and keep the contents of the box stirred up, so that the overflow water will carry off the silt or loam.

**Quality of aggregates.** Aggregates that are soft, such as would come from shale rock, are not suited to concrete. Sand should be what is known as siliceous; that is, it should consist of particles of quartzlike rock. Pebbles should be hard and round or egg-shaped, rather than flat and long. As pebbles of the latter shape will not compact solidly, they will not make dense concrete.

When stone screenings are used in place of sand, they should be the product of crushed trap rock or granite. If broken stone instead of pebbles is used for coarse aggregate, it should have been obtained by grinding granite, hard limestone, or trap rock. Sometimes slag is used for coarse aggregate. There are various kinds of slag, however; but only slag which is the refuse from blast furnaces in smelting iron ore is suited for concrete aggregate. Slags that come from other ores usually contain free chemicals which may act injuriously on the cement. One exception to the foregoing statement is material known as "chats." This is the waste material obtained in the process of smelting, or reducing, zinc ores. It makes a good aggregate, but cannot be obtained in graded sizes, as it almost invariably runs from half inch downward in grading.

FIG. 417. Leveling the surface of a feeding floor with floats. Note the "bridge;" also the screen over the finished section to prevent too rapid drying.

**Fire-resisting aggregates.** Another point should be borne in mind in selecting aggregates, and that is their ability to resist fire. Concrete is recognized as a highly fire-resisting building material. The degree of fire resistance it has depends largely upon the aggregates. In the process of manufacture, portland cement is subjected to very high heat, so that in itself it is highly fire-resisting. Trap rock and slag are fire-resisting rocks, because in nature they resulted from a transformation in which high heat was present. Granites, although hard, tend to burst, when exposed to high heat, while most limestones disintegrate or crumble when exposed to heat, because, as nearly every one knows, quicklime is made by burning limestone. Therefore, for high fire-resisting qualities, aggregates must be selected with the above consideration in mind.

**Adaptability of concrete.** Concrete is a most adaptable building material. This is due to the fact that, when the mixture is finished, it is in what we might call a plastic form. If immediately placed in forms or molds and then allowed to remain undisturbed, it will harden and assume the shape of the mold, or form, in which it has been placed.

The advantages of concrete are that it is a strong material, may be easily prepared and used, and, when properly employed, makes to all intents and purposes a permanent fireproof structure—more nearly so than can be secured with any other building material. Also, it makes a structure that is water-tight, and one that can readily be kept clean, which means sanitary.

Most of the materials of which concrete is made may be obtained anywhere. There is hardly a farm that has not on it or near by a


FIG. 418. The essential tools for concrete work are easy to get on the farm: *a*, rake for spreading; *b*, metal wheelbarrow; *c*, wooden float; *d* and *e*, shovels, the first better for mixing; *f*, pail; *g*, water barrel; *h*, sand screen; *i*, iron tamper for foundation.

gravel pit from which the necessary sand and pebbles may be obtained. Cement is sold in practically every town. The little reinforcing steel that may be needed is about the only thing that has to be shipped in; while, under careful supervision, common labor can do the greater portion of the work. Any intelligent farmer who is willing to observe a few simple rules that mean success with concrete can build almost any farm structure with the help of his farm labor.

**Tools required.** The tools required are few and simple. Practically all of them are already a part of the farm equipment or may be home-made. A screen for separating sand from pebbles has already been described.

A mixing platform may be made by nailing 1 x 4-inch tongued-and-grooved boards on 2 x 4 stringers placed 2 feet apart. Tongued-and-grooved boards are specified, because it is necessary that the platform be tight, so that, when water is added to the other materials, the cement will not be washed away. The platform should not be less than 8 by 10 feet square; and there should be nailed 2 x 3 stringers around 3 sides, so that, when turning the materials in shovel mixing, they will not be thrown off the platform.

Concrete is usually proportioned by volume, and in such proportioning 1 sack (94 pounds net) of portland cement is considered 1 cubic foot. Therefore, the cement need not be measured unless the quantity of concrete required calls for less than a sack of cement. On most work, however, the job will call for more than a 1-sack batch; therefore, it is always well to mix batches that require 1 sack of cement. This does away with the necessity of measuring that ingredient.

For measuring sand and pebbles or broken stone, a bottomless frame will serve as a measuring box. This may be of any capacity from 1 cubic foot upward; not larger than from 3 to 5 cubic feet is best. This box should have, marked around the interior, lines indicating capacities of 1, 2, 3, etc., cubic feet, so that, if it is desired to measure any quantity less than the full capacity of the box, definite known volumes may easily be obtained. In use, the box is set on the mixing platform and the required quantity of materials placed in it; it is then lifted, and, if necessary, again filled.

Square-pointed shovels are needed for mixing the materials. A hose, or in its absence, a water barrel and pails will be required for handling water. A wheelbarrow may be needed, to move the concrete from the place where mixed to that where deposited. A wheelbarrow with a steel body is best. It should be cleaned out each time after use, so that it may not eventually become filled with particles of hardened concrete.

About the only other tools necessary are a strikeboard, to level off the concrete when being used in forms for walk or floor construction; a wooden hand float, to finish the surface; a steel trowel for smoother finishing, if needed; and, when walks, floors, and similar pavements are being made, a groover or jointer and an edger, to finish properly the joints and edges of slabs. These last-mentioned tools may be obtained in any hardware store.

## Concrete Mixtures and Their Preparation

For very accurate results, concrete is proportioned after quite extensive tests have been made on the sand and pebbles or broken stone, to determine the percentage of voids, or air spaces, in their volume. For most work, such scientific or exact methods are not necessary. The concrete is, in most cases, proportioned after what are known as arbitrary methods. This practice is most common on the average run of work, and is satisfactory because long experience has shown that certain mixtures, presuming that the materials are well graded, answer for certain classes of work.

FIG. 419. Screening sand. Clean, sharp aggregates are as necessary as good cement

Mixtures are described 1:2, 1:3, 1:2:3, 1:2½:4, 1:3:5, etc. A 1:2 mixture means that the concrete is composed of 1 part, or 1 volume, of cement and 2 parts, or 2 volumes, of sand. In other words, a 1:2 or a 1:3 or a 1:1½ mixture means a sand-cement mortar. The first figure stands for cement; the second, for sand. In a 1:2:3 mixture, for instance, we have a third figure. This refers to the volume of coarse aggregate—pebbles or broken stone; so that a 1:2:3 mixture means 1 part or 1 sack of portland cement, 2 cubic feet of sand, and 3 cubic feet of pebbles or broken stone.

**Tables of mixtures.** In the following table of so-called arbitrary mixtures are given the ones commonly used and recommended for the classes of concrete construction indicated for each. From this table the reader will be able to select mixtures suited to almost any class of work, if he will bear in mind that walls, floors, and pavements, for example, belong to one construction; that fence posts, hitching posts, and clothesposts make up another class; that watering troughs, feeding troughs and tanks are similar, and so forth.

TABLE OF ARBITRARY MIXTURES

1:2 mixture.
Used for wearing course of 2-course floors.

1:2:3 mixture.
Used for concrete roofs; 1-course concrete walks, floors, driveways, barnyard pavements, fence posts, watering troughs, and tanks, such as cisterns, reservoirs, etc.

1:2:4 mixture.
Used for concrete walls and reinforced concrete work in general.

1:2½:4 mixture.
Used for silo walls, grain bins, building walls when stucco finish is not to be applied, manure pits, dipping vats, hog wallows, and similar classes of construction.

1:2½:5 mixture.
Used for building walls that are to be stuccoed; base of 2-course walks, feeding floors, barnyard pavements; basement walls and foundations for ordinary conditions where water-tightness is not essential.

1:3:6 mixture.
Used for heavy foundations and footings.

MORTARS

1:1½ mixture.
Used for inside plastering of tanks, silos, and bin walls, if necessary.

1:2½ mixture.
Used for fence posts, when fine aggregate only is used.

**Mixing concrete.** Concrete may be mixed either by hand or by machine. Good concrete may be mixed either way. If only small quantities are to be made, hand mixing will probably be found most convenient; but, if the work is of any considerable volume, machine mixing will insure a more thorough mingling of ingredients and will considerably reduce the labor of mixing. Small power-operated mixers in almost endless variety, and all of them efficient, may be obtained at relatively low cost. They are to be recommended wherever the amount of work to be done warrants obtaining one. Frequently, farmers in a community unite and purchase such a machine and use it jointly as needed, thus making its cost practically nothing to each of those who are interested in it.

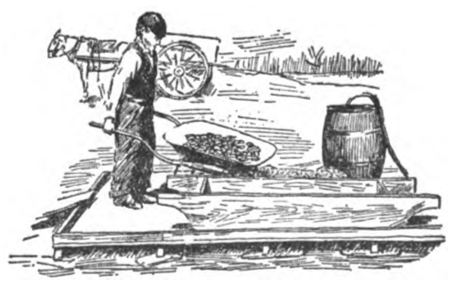


FIG. 420. Water-tight mixing floor with bottomless measuring box in foreground, and water barrel in rear. The edging around the floor is handy, but not essential.

**Hand mixing.** If concrete must be mixed by hand, the following method should be used: Measure the required amount of sand. Spread it out in a thin layer on the mixing platform. Dump on this the correct quantity of cement. Turn the cement and sand thoroughly 3 or 4 times, using a square-pointed shovel, until the entire mass is of a uniform color, absolutely without streaks of brown or gray. Measure out the required quantity of pebbles or broken stone. Sprinkle it so that everywhere the surface is wet. Add it to the mixed sand and cement. Turn the entire mass once or twice. Then add water, preferably from a hose spray or from a sprinkling pot, while some one keeps turning the sand and pebbles, so as to prevent the cement from being washed away. Turning should be continued until the mass is of a quaky, or jellylike, consistency.

**Quantity of water.** Too much water is as bad as too little. The right consistency in concrete mixtures is very important, for several reasons. Correct proportions and correct consistency insure water-tight concrete. A mass that is mixed too dry cannot be compacted to the utmost density in the forms, and will not make water-tight concrete. A quaky, or jellylike, consistency will not flow. If placed in a pile, it will remain as placed until slightly disturbed, when it will tend to flatten out. It can be carried on a shovel without spilling, while a wetter mixture will flow and will cause the sand-cement mortar to separate from the pebbles.

**Machine mixers.** Practically all makes of mixers to-day are of what are known as the "batch type." This means that separately measured materials must be placed in the drum thus insuring that each batch is properly proportioned and not the result of guesswork. Mixers come in various capacities. Small ones for farm use may be had for $75 and upward, in most cases complete with gasoline engine to operate. Several manufacturers make small mixers in which the drum, or mixing receptacle, consists of a barrel which has vanes or blades mounted on the inside. The barrel is revolved until the concrete is mixed, and is then tilted, to dump out the contents. Other mixers have cylindrical or cube-shaped drums; but all have certain fundamental principles in common.

FIG. 421. A small engine-driven concrete mixer, good for the farmer who does much construction work. It is tipped and emptied by means of the crank.

The choice of a mixer for farm use is largely a matter of deciding upon the capacity which it is desired the machine shall have, rather than upon its make. In this connection it may be well to mention that many farmers make their own patent fertilizer, and that those who have been most successful have mixed the ingredients in a medium-sized batch concrete mixer. This illustrates the point that a power-operated mixer can be made to earn its cost in another way than in using it for concrete construction.

**Time of mixing.** When mixing concrete by hand, the tendency is to slight the operation somewhat, because there is some work about hand mixing and the men on the job get tired toward the end of the day, and later batches are likely to be not so well mixed as earlier ones. No definite time for mixing can be stated, when hand mixing is being followed. Then it is simply a question of turning the materials until the mass is of a uniform color and consistency and the various materials have been thoroughly combined with one another. A machine mixer does not get tired, and the time of mixing can be definitely stated. After all materials have been placed in the drum, it should be revolved for a definite number of revolutions or a definite period of time. Manufacturers base the number of revolutions on the time required to make them, and this usually amounts to at least 1 full minute of mixing. One minute and a half, however, is better, since it has been proved that the time occupied in mixing has great influence on the strength of the resulting concrete.

No more concrete should be mixed at any one time than can be used within about 30 minutes. Neither should sand and cement be combined any considerable time in advance of adding the pebbles or broken stone and mixing water. Dampness of the sand will cause the cement to commence hardening, and thus destroy part of its effectiveness when the remainder of the materials are added and the batch of concrete completed. Loam and clay are more likely to remain moist than is clear sand, which is one reason why the latter should be carefully chosen and, if necessary, washed before it is used. The hardening action that takes place when cement and water are combined commences very soon after the combination. This will have progressed far enough within a period of 30 minutes, so that after that time any unused concrete should be thrown away. Neither concrete nor mortar that has commenced to harden should be retempered, as it is called, by adding more water and remixing. Such concrete or mortar will not have full strength.

## Forms

**What they are.** Forms, or molds, are the receptacles in which concrete is placed immediately after mixing, so that, when hardened, it will take the shape desired. For most work, forms are made of wood. Where a particularly smooth surface is desired as on an exposed wall face, forms should be of planed lumber. A still smoother finish can be obtained by lining the forms with sheet steel. The concrete will stick less to forms made of planed lumber or lined with metal forms than to those made of rough lumber. Also, the concrete surface resulting from the use of well-made forms is much more pleasing.

In foundation work, forms are often unnecessary for that portion of the work below ground; that is, when the earth is so firm that the walls of the trench are self-sustaining. When concrete has been placed to ground level, forms will, of course, be required for any further work. For a basement or cellar wall, it may be that only an inside form will be needed. It is necessary, of course, where the foundation is to serve as an inclosure for the basement or cellar, that the interior face of the work be smooth and well-finished. It is also necessary that the foundation wall be water-tight, and in such cases the concrete can be placed more satisfactorily by using forms than by depending solely on the earth trench.

**Form construction.** For small buildings, form studs, or uprights, to which the sheaths, or form boards, are nailed, may be 2 x 4's or 2 x 6's, placed from 18 inches to 2 feet apart. The sheathing boards must be either tongued and grooved or tightly jointed on the edges by being planed, so that cement and water will not run through joints while the concrete is being placed. Only ordinary carpenter skill is required to build forms for most concrete work; but all concrete form work requires careful thought, to plan for window and door-

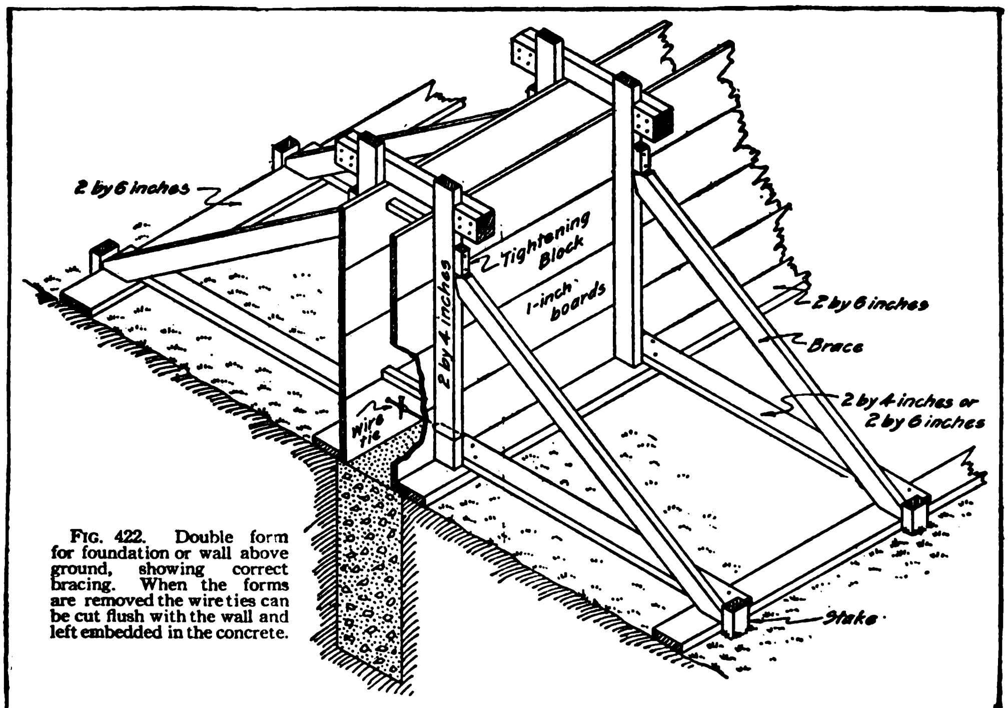



FIG. 422. Double form for foundation or wall above ground, showing correct bracing. When the forms are removed the wire ties can be cut flush with the wall and left embedded in the concrete.

way openings and for any other departure from a plain, straight surface in the structure being built.

**Setting up forms.** Forms must be set up plumb and straight to line and be well braced with stiff braces, to prevent them from bulging out of shape, from ramming or compacting of the concrete when placing. They must also be set at the correct distance apart and tied or clamped, so that they will remain the required fixed distance apart while the concrete is being placed, in order that the concrete section wall, or whatever it may be, may have the required thickness. Wire ties, or bolts, drawn against wood spacers in the forms are used to hold them a fixed distance apart. As the concrete is placed up to the wood spacers, the latter are removed.

**Ties and spacers.** When wire ties are used, they are usually cut when the forms are removed, the main piece of wire is left in the concrete, and the projecting ends are cut off, the wire ends being hidden by pointing up or plastering the holes with a little cement-sand mortar. If bolts are used as form ties they must be greased before the concrete is placed, so that they can be knocked out of the concrete afterwards. The resulting holes are then pointed or plastered up with cement mortar.

**Wetting or oiling forms.** Before concrete is placed, the forms should be well wet down, to prevent the concrete from sticking. Sometimes, forms are wiped or lightly painted with a mixture of linseed oil and kerosene, to prevent the concrete from sticking. This is very effective, but not so economical as wetting them down. However, if forms must be used a number of times, oiling them before use each time makes them last longer, because the lumber absorbs the oil, thus preventing absorption of water from the concrete and, in turn, preventing warping and bulging.

**Kind of lumber to use.** For most form work, air-dried lumber is better than green or kiln-dried lumber. Green lumber is likely to dry out, causing cracks between sheathing boards, while kiln-dried lumber is likely to bulge and swell through absorbing water from the concrete.

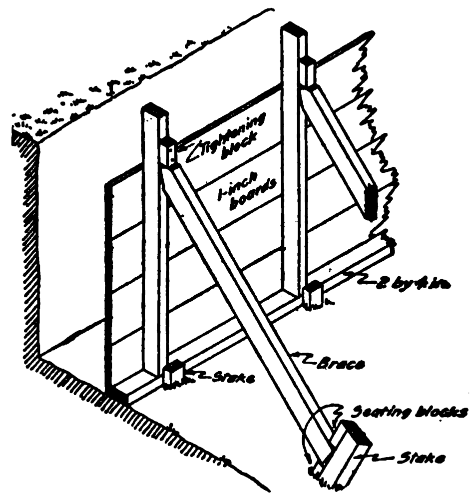



FIG. 423. Simple form for a retaining wall or foundation where the soil is firm enough to provide one side

**Form removal.** A very important detail of concrete work has to do with the time of form removal. Concrete hardens best in moderately warm weather, provided it is not allowed to dry out rapidly. Forms can often be removed from wall sections in from 24 to 36 hours after the last concrete is placed. In cold weather, concrete hardens very slowly. It is not possible to say definitely when forms may safely be removed from any concrete work. This is a matter dependent entirely upon the temperature and weather conditions under which the concrete has hardened, and the proper time for removal must be determined by experience coupled with good judgment.

## The Placing of Concrete and the Treatment of Surfaces

Immediately after mixing, concrete should be placed. The mixing platform, or mixer, should be as near as possible to the place where the concrete is to be used, so that the material will not have to be handled unnecessarily. It should be shoveled directly from the mixer platform into the forms, or dumped direct from the mixer into them. If a quaky concrete is being used, it should be puddled or spaded in the forms. An old garden spade flattened or a hoe straightened out makes a good tool for this purpose. It is used by working it up and down in the concrete next to and between the form faces, so as to settle the concrete thoroughly. The more spading that is done next to the form faces, the denser and smoother will be the resulting concrete surface, because spading forces back the coarse particles, and allows the sand-cement mortar to come next to the forms, thus preventing pebble pockets on the surface.

Concrete should be placed in layers of from 6 to 8 inches. Deeper layers

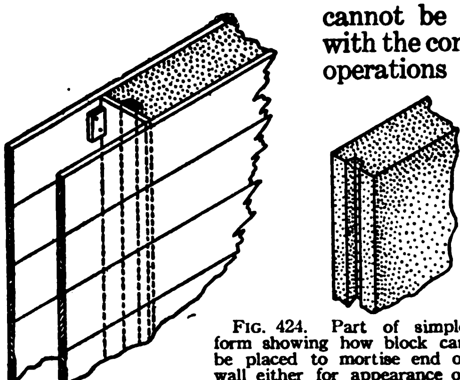


FIG. 424. Part of simple form showing how block can be placed to mortise end of wall either for appearance or to admit a sliding division board, a door frame, or the tongue of another section of wall with which a strong joint is desired.

cannot be properly spaded so that they will unite with the concrete previously placed. Also, concreting operations should be carried on as continuously as possible, so that there will be few construction seams or lines of cleavage in the work. This is especially necessary when tanks, troughs, and similar receptacles that must be water-tight are being built. Sometimes, however, it is not possible to continue the work without interruptions; in such cases, when leaving off work, the concrete should be roughened in the forms. Then, when concreting is resumed, this roughened surface should be scrubbed with a broom and water and painted with a cement mortar paint made by mixing portland cement and water until a creamlike mixture results. This paint is then applied to the scrubbed surface in the forms and fresh concrete placed at once. If properly done, this will prevent a leaky construction joint.

**Protecting finished work.** The action which takes place when cement and water are combined is a chemical one. The process is technically called "hydration." It is commonly referred to as "a process of crystallization," and this accurately describes it. A certain amount of water is necessary to complete this chemical change, or complete crystallization, which leads to hardening, in other words, to make the cement set. This setting of cement is what causes the hardening of concrete. It cannot take place properly, naturally, and completely unless all of the water which is used in making the concrete mixture can be retained in the concrete until hardening is complete. To insure this, it is necessary that when the work is finished it shall be protected in some way to prevent loss of water. Many persons have the wrong impression that the hardening of concrete is a drying action. This is exactly the reverse of what should take place. If the concrete is allowed to dry out, it will not attain the same degree of hardness as when prevented from drying out. Therefore, when concreting has been finished, some means must be taken to protect the work. What this protection must consist of depends upon the nature of the work and the time of year. Sometimes, the only protection required is that secured by leaving the forms in place for several days and keeping the work thoroughly wet down. In other cases, the work must be covered with wet burlap, hay, straw, or similar material, and this covering be kept wet down for several days. Many leaky tanks, troughs, walls, etc., have resulted from failure to protect the concrete after placing. This one detail is very important; indeed, it is almost equal in importance to the correct proportioning, mixing, and placing of materials.

**Finishing concrete surfaces.** A concrete surface may be given several different kinds of treatment, if it is desired to vary the appearance from that obtained merely by contact with the forms. If forms are well made and the concrete is properly placed, no after-treatment is needed for the average concrete surface; but, as concrete is very faithful in reproducing any irregularity of form work, it may be necessary to go over the surface in some way, to remove unpleasing irregularities.

**Rubbed surfaces.** Probably the simplest treatment that can be given a surface is to go over it with a brick or carborundum stone after the forms are removed, keeping the surface wet, and rubbing all over with the brick or stone, to grind down form markings. Sometimes, a cement water paint is applied, but as a rule such applications peel off after a while and leave the surface more unsightly than were no such treatment given.

**Colored surfaces.** Concrete can also be

colored by combining with the mixture a small amount of some mineral coloring matter. Only mineral pigments should be used, because in time other colors fade and they usually fade unevenly, so that the resulting surface is much more displeasing than it would have been if no attempt had been made to color it.

**Slap-dash and pebble-dash.** Concrete surfaces that are to be plastered or stuccoed can be varied in a number of ways. Usually, a thin mortar is thrown against the concrete surface from paddles. After a little experience, very pleasing surfaces can be produced in this way, the mortar being colored with mineral pigments; and, if the work is properly done, the surface is referred to as having a "slap-dash" finish.

A "pebble-dash" finish is secured by plastering the surface with cement mortar as soft as can be worked under the trowel and, before this mortar has commenced to harden, throwing against it clean, hard, uniformly graded pebbles. If before they are thrown against the surface, the pebbles are wet with cement water paint, they will adhere more firmly to the surface.

**Tooled surfaces.** Sometimes, a concrete surface is tooled, this usually being done by going over it with a bush-hammer or pein hammer, such as stonecutters use. A concrete surface cannot be finished in this way, however, until it is 36 days or more old, so that the hammer or cutting tool will not dislodge or loosen particles of aggregate from the surface. This manner of finish is laborious and somewhat expensive and is not often used, except on buildings that require some treatment to produce a desired architectural effect.

**Washing and scrubbing the surface.** Other surface finishes are secured by washing or scrubbing off the film of cement from the surface of the aggregate particles. Washed surfaces, however, are usually confined to more or less ornamental objects such as vases, lawn benches, sundial pedestals, etc. Preparation for securing such surfaces is usually made when the concrete is mixed, and consists principally of using selected aggregate for some desired color that it is intended to expose on the concrete surface by the scrubbing or washing process. If forms can be removed within 24 hours after the concrete has been placed, the aggregate surfaces can usually be exposed by scrubbing down the concrete with a stiff brush and water. If, however, the concrete has hardened too much to allow this, it is necessary to use an acid wash. A common one consists of 1 part muriatic acid to 3 or 4 parts of water. Scrubbing must be done quickly, the work watched carefully, and the surface drenched with water immediately the surface film of cement has been removed, so that the action of the acid will be stopped. Otherwise, it would go on acting with the cement and would finally loosen the aggregate particles from the surface.

**Painting.** Very rarely is a concrete surface painted. If, however, it is desired to paint the concrete, a paint prepared especially for that purpose must be used and the concrete must be dry and thoroughly hardened before the paint is applied. There are in concrete some free lime and other chemicals that act on ordinary paints and prevent them from adhering permanently to the concrete.

**Waterproofing.** No waterproofing treatment is necessary with concrete that has been properly proportioned, mixed, placed, and protected after finishing. If, through faulty workmanship, however, the concrete is not water-tight, there are several treatments that can be applied to render it so. One of these is what is known as the Sylvester process, which consists in the application of alternate solutions of soap and alum to the surface. Details of the treatment are as follows:

Two solutions are used in this treatment. The first consists of three-quarters pound of soap to 1 gallon of water; the second of half pound of alum to 4 gallons of water.

The surface to be treated should be perfectly clean and dry.

The soap wash should be painted on when at boiling heat. This should remain 24 hours, after which the second, or alum, wash should be painted on in the same manner. These coats may have to be repeated alternately a second time, until the walls are made impervious to water. The alum and soap thus combined form an insoluble compound, filling pores in the concrete.

Another treatment for the same purpose consists in painting the surface several times with a solution of water glass in water. Water glass is chemically known as silicate of soda. This chemical, also, reacts with free chemicals in the concrete and closes the pores. Several applications may be necessary to produce the required effect.

Various compounds are sold as waterproofing mediums. Some of these are mixed with the dry materials when the concrete is proportioned; others are applied to the finished work; and, while all of them have something to recommend their use, none of them will take the place of good workmanship. In other words, the workmanship cannot be slighted merely because some one of these waterproofing compounds is being used.

## Reinforcing Concrete

Probably the most notable property of concrete is its compressive strength; that is, its ability to carry heavy loads placed directly upon it. In fact, the first

use that was ever made of concrete was to build mass work or heavy foundations. Experiments with concrete proved, however, that it was possible to extend its use to practically every part of the building by imbedding in it reinforcing material in the shape of steel-wire mesh or steel rods. Concrete is not very strong in tension, that is, in resisting loads that tend to bend it or pull it apart. But, if suitable reinforcing material be placed in it, it can be used for beams, roofs, columns, and other parts of structures, just as any other building material may be used, and with decided advantage, as compared with other materials, because concrete is fireproof and, unlike other materials, grows stronger as it grows older.

**Where reinforcing is necessary.** As a rule, concrete foundations do not require reinforcing. Building walls, however, over a certain length should have suitable rods or mesh fabric embedded in them, to take care of stresses or strains resulting from changes of volume in the concrete under different temperature conditions, because concrete, like other material, expands and contracts as the temperature rises and falls. Reinforcing is necessary in some other uses of concrete, such as beams, columns, fence posts, etc. Probably no better example of the principle of reinforcing concrete can be chosen than the ordinary fence post. If a concrete fence post were made without reinforcing, it would probably break in the fence line very quickly because of the pull of the fence wires on it. Or, if not from this cause, if stock tried to break in or out of the inclosure, it would not take much of a blow to break the post off at the ground. If steel rods are properly placed in the concrete, such breaking cannot occur. But the rods must be properly placed. Many persons think that a single rod or piece of gas-pipe at the centre of the post accomplishes all that is necessary in the way of reinforcing. This can readily be proved incorrect by reference to the two accompanying sketches.

The first (Fig. 425) is supposed to illustrate a beam which has been cut in two at its centre and joined by a hinge. The two ends of the beam rest on supports, as shown. At the top of the hinged joint is supposed to be a block of rubber; at the bottom, a coiled steel spring. It requires no imagination to see that, if a load is placed on top of the beam, it will bend at the hinged joint; and, supported at the two ends as it is, this bending under load will tend to close the gap at the top, where the piece of rubber is inserted, and, at the same time, make the gap at the bottom, where the coiled spring is, wider. In other words,

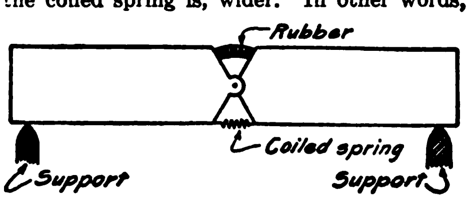



FIG. 425. Diagram showing the effect of the strain on a supporting beam held at the ends (See text)

the rubber will be squeezed together, or compressed, while the spring will be pulled, or lengthened; that is, the spring will receive the pulling strain and, at the same time, will tend to resist the bending. Suppose now that, instead of being broken and hinged as shown, the beam is made solid and a steel rod is

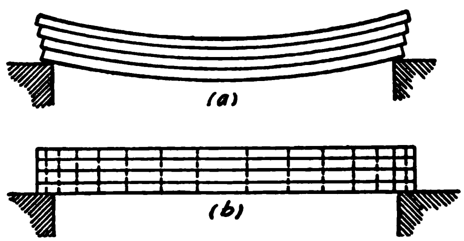



FIG. 426. Diagram showing how and why vertical reinforcing is effective

imbedded in the concrete, say, half inch or more from the lower face of the beam. The adhesion between the concrete and steel will compel the steel to resist the tendency to bend; that is, it will take up the tensile strain brought about by the load on the beam.

Another example is given in the second illustration (Fig. 426). This shows the manner in which the bending strains on a concrete beam act and may be resisted. Figure *a* is intended to show several planks or boards, laid one on top of the other and separated at their ends. If they are long enough, they will naturally bend from their own weight, while, if a load is placed upon them, they will bend still more and in bending will slip past or along each other, thus causing their ends to become uneven, as shown. If these planks are bolted together, as shown in Figure *b*, the slipping will be prevented and the planks will lie practically straight.

The principle of reinforcing concrete is applied by every farmer who has strengthened his singletrees to withstand the pull or strain of the team by bolting a piece of strap iron along their back face.

Steel is to be preferred above all other materials for reinforcing concrete. In fact, steel is the only material used. The reason for this is that steel is the only material which expands and contracts under changes of temperature in the same degree or ratio as

does concrete.[1] This is very necessary, as it prevents the breaking of the bond, or adhesion between the concrete and the reinforcement; and this bond, or adhesion, is necessary to secure the full effectiveness of the reinforcement.

**Installing fittings in concrete.** Anchor bolts, hinge eyes, and various other fittings that are to be attached in concrete for setting machines or for hanging gates or doors should be arranged for when the forms are made. Anchor bolts can be suspended from cross-pieces resting on forms (Fig. 427).

Anchor bolts for setting gas engines are placed in a similar manner. In such cases, however, care must be taken to make an accurate template, bored so that the position of holes in it will correspond exactly to the position of holes in the machine or other device to be set.

Concrete can, of course, be drilled and bolts be leaded in place after the work has been finished, but it is much more satisfactory to provide for them at the time the work is going on.

The desirability of using concrete as largely as possible in farm buildings has often been urged elsewhere in this work. In the following paragraphs, the places where it may be advantageously employed by the farmer are more specifically set forth together with some helpful information in reference to dimensions of various structures and to the materials for concrete and reinforcement.

## Some Things a Farmer Can Make With Concrete

**Floors, walks, driveways, etc.** Floors, walks, and driveways are similar classes of concrete pavements. A description of one serves as a guide for the construction of the others, with but a few minor exceptions.

Perhaps the most profitable kind of concrete floor that the farmer can lay is a feeding floor or barnyard pavement. On such floors no grain or fodder fed to animals is lost, nor is any trampled in the mud. Floors in dairy barns or cow stables and in hogpens are desirable, profitable, and sanitary improvements. All of these classes of floors are usually laid on the ground. A feeding floor is built just like a sidewalk. In fact, a feeding floor is nothing but a series of sidewalks laid side by side.

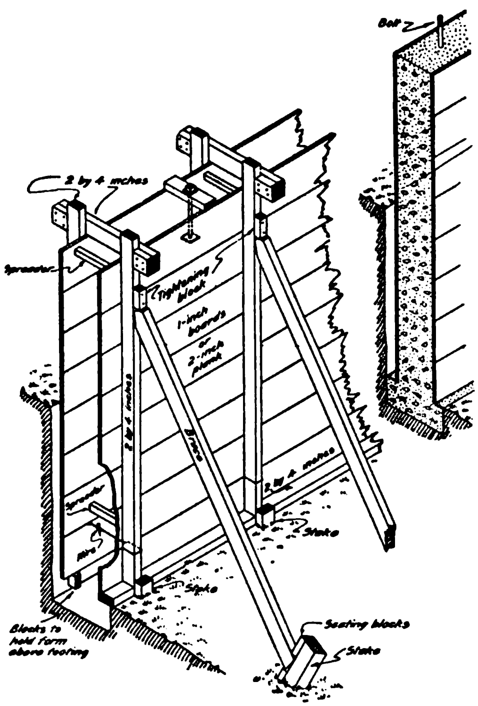



FIG. 427. Double forms for foundation extending both below and above the surface, and with a footing. Note how bolts or other fittings are installed by being hung in place before the concrete is poured.

Feeding floors, barnyard pavements, and dairy-barn floors must be laid on firm, well-drained soil. If the area where the floor is to be laid is not firm, it should be made so by thorough rolling and tamping. If the soil is not well drained, then tile drains should be laid at the edges of the floor, these drains leading to some suitable outlet, so that water will be kept from beneath the concrete. Feeding floors are usually made 5 inches thick and of a 1:2:3 one-course concrete. This means that the same mixture of concrete is used for the entire thickness of the floor. Two-course floors or pavements consist of a 1:2½:5 base on which is laid a 1:2 cement-mortar top, or wearing course. The base is usually 4 inches thick, and the top, or wearing, course, 1 inch. Where floors, walks, driveways, or similar pavements are to be used by loaded wagons, they should be not less than 6 inches thick.

Feeding floors and barnyard pavements are usually built in slabs from 5 to 6 feet square, but in no case exceeding 10 feet square.

Concrete walks about the farm are rarely more than 3 feet wide, and the slabs may be from 3 to 5 feet long. Walks are sometimes made no more than 4 inches thick. This is all right where there is little freezing and expansion of wet soil; but, in general, a thickness of 5 inches is to be preferred. One-course construction is better than 2-course, because there is no possibility of separation between the base and the top course, as sometimes happens in 2-course work when the top course is

not laid until after the base has commenced to harden.

Finishing concrete walks, floors, and pavements with a wooden float is better than finishing them with a steel trowel. A wooden float gives an even, yet gritty, texture to the surface, that provides a good foothold for man as well as for beast.

Protection of concrete floors and pavements immediately after laying is very important. As soon as the concrete is hard enough to resist the pressure of one's thumb, it should be covered with a 2-inch layer of moist earth. This covering should be kept wet by sprinkling several times daily for a week, before the walk or floor is put into use. If the pavement is to be driven over, it should remain unused for at least 2 weeks after laying.

Concrete feeding floors are usually built with a curb and apron around them. The curb prevents animals from shoving food off while eating, while the apron, extending down 12 inches or more below the base of the floor, prevents hogs from rooting underneath.

Concrete feeding floors and barnyard pavements are easily kept in sanitary condition. It is customary to slope such floors and pavements slightly in 2 directions and at the low point to connect with a tile drain leading to a concrete manure pit. This arrangement saves every bit of fertilizer and adds to the profit of the improvement.

**Foundations.** For most buildings that require strength rather than water-tightness, foundations are made of a 1:2½:5 or a 1:3:6 concrete. For small farm buildings like poultry houses and hoghouses, which are rarely more than 1 story high, foundation walls need not be more than 6 or 8 inches thick. It is difficult, however, to dig such a narrow trench to proper bearing soil; consequently they are often made thicker, especially when the concrete is to be deposited without forms. If, however, excavating would have to be continued too far to reach firm bearing soil, then the trench is made wider and the foundation started by first laying a footing (that is, a layer of concrete 6 inches or more high and 10 inches or more wide), to distribute the load of the building over a greater area of soil, thus helping to prevent settlement. No fixed rule can be given for the thickness of foundation walls nor for the width and thickness of footings, as these depend on the size of the building and hence the load that the soil is to carry.

For poultry houses, hoghouses, and dairy buildings, footings may be made 6 to 8 inches high and from 10 to 12 inches wide. On top of this the foundation wall proper is started. Eight inches is usually thick enough for such small buildings. When ground level is reached, the thickness of the wall may, in most buildings of the kind mentioned, be reduced to 6 inches.

For 2-story houses, foundation walls should be about 10 inches thick and should start on a footing 10 inches high by 15 inches wide. For heavy barns, foundation walls may be from 10 to 12 inches thick and should start on a footing 10 to 12 inches high and from 20 to 24 inches wide.

In each of the foregoing cases, the dimensions for footings are only approximate, as the bearing capacity of the soil and the weight of the building to be carried are the final determining factors.

**Troughs, tanks, manure pits, and hog wallows.** Among the most common uses of concrete on the farm is its application in the building of watering troughs or tanks. Manure pits, cisterns, hog wallows, etc., are merely other forms of tanks and, like the first-mentioned, must be water-tight. Watering troughs, tanks, and cisterns should be made of a 1:2:3 concrete, while manure pits and hog wallows may be made of a 1:2½:4 mixture. In tank construction, it is important that the work be carried on continuously, if possible, to prevent seams in the work through which leakage may occur. However, there is a way to prevent leakage in such seams, if directions are carefully followed, and these have been given above.

Manure pits are usually built partly beneath ground, for convenience in throwing manure into them. Often they are built so that one end has a sloping pavement leading into it, for convenience in backing a wagon into the pit for loading. Manure pits are sometimes connected with cisterns for the purpose of draining into these receptacles the liquid content of the manure. This is pumped from the cistern from day to day and either sprinkled over the manure in the pit, to regulate decomposition, or is hauled in tank wagons to the fields and there sprinkled on the ground. The cistern for the manure pit should be of 1:2:3 concrete, to insure that the walls are thoroughly water-tight, thus preventing seepage of the contents and possible contamination of the domestic water supply.

All kinds of tanks, manure pits, and hog wallows must be properly reinforced. No table of reinforcement can be given for such structures, because each change in shape and size

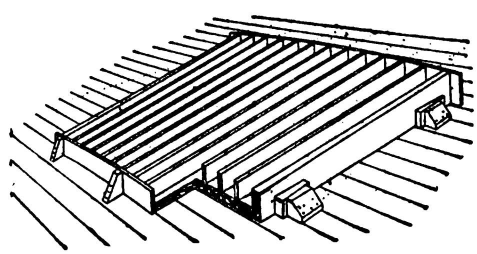


FIG. 428. Series of fence-post forms partly cut away in front to show simple construction. Reinforcing rods should be used in these.

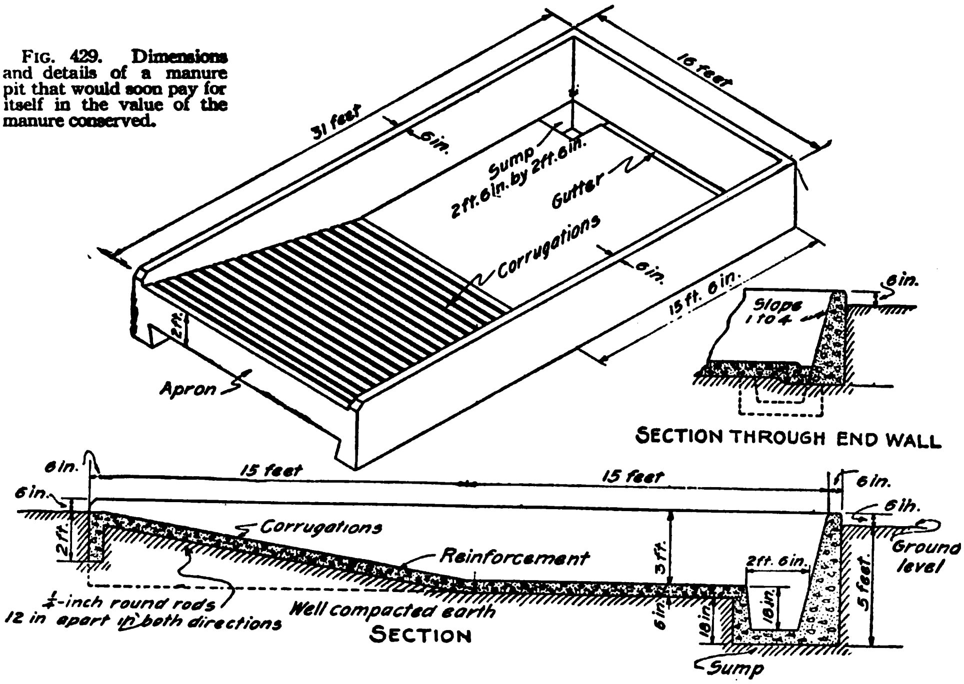



FIG. 429. **Dimensions and details of a manure pit that would soon pay for itself in the value of the manure conserved.**

**makes a different structure for which reinforcement must be specially calculated.**

**Concrete water tanks in the barnyard or pasture lot should have a concrete pavement laid around them or, at least, on the side from which cattle approach the trough to drink, so as to prevent the surroundings from becoming a mudhole.**

**The inside face of small watering troughs should be battered, or sloped, so that the walls of the tank or trough will be thicker at the bottom than at the top. This detail of construction helps to relieve the tank from pressure due to ice, when water in the tanks freezes.**

**Posts. Posts of various kinds—clothesposts, gateposts, etc.—can be readily made in concrete during spare hours on the farm. For ordinary fence posts, gang molds can be made of wood, the capacity of such molds being based on one filling with a 1-sack batch of 1:2:3 concrete. If any considerable numbers of fence posts are to be made, however, some one of the many good types of metal commercial molds is to be preferred, because a**

TABLE I—DIMENSIONS OF CONCRETE LINE POSTS, AND MATERIALS NEEDED

| DIMENSIONS | | | Weight of post in pounds | Amount of reinforcing metal required | MATERIALS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 1 part Cement to 3 parts Sand | | | 1 Cement, 2 Sand, 3 Pebbles or Stone | | | |
| | | | | | No. posts per barrel cement | FOR 10 POSTS | | No. posts per barrel cement | FOR 10 POSTS | | |
| Length in feet | Top in inches | Bottom in inches | | | | Sacks cement | Cubic feet sand | | Sacks cement | Cubic feet sand | Cu. ft. pebbles or stone |
| 6½ | 3 x 3 | 5 x 5 | 107 | Four | 15.1 | 2.6 | 7.9 | 21.1 | 1.9 | 3.8 | 5.8 |
| 7 | 3 x 3 | 5 x 5 | 115 | ¼-inch | 14.0 | 2.8 | 8.5 | 19.5 | 2.1 | 4.2 | 6.2 |
| 7½ | 3 x 3 | 5 x 5 | 123 | round | 13.2 | 3.0 | 9.1 | 18.4 | 2.2 | 4.4 | 6.6 |
| 8 | 3 x 3 | 5 x 5 | 131 | rods | 12.3 | 3.2 | 9.7 | 17.1 | 2.4 | 4.7 | 7.1 |
| 6½ | 4 x 4 | 5 x 5 | 133 | Four | 12.2 | 3.3 | 9.8 | 17.0 | 2.4 | 4.8 | 7.2 |
| 7 | 4 x 4 | 5 x 5 | 143 | ⁵⁄₁₆-inch | 11.3 | 3.5 | 10.6 | 15.8 | 2.6 | 5.1 | 7.7 |
| 7½ | 4 x 4 | 5 x 5 | 153 | round | 10.6 | 3.8 | 11.3 | 14.7 | 2.8 | 5.5 | 8.2 |
| 7¾ | 4 x 4 | 5 x 5 | 163 | rods | 9.9 | 4.0 | 12.1 | 13.8 | 2.9 | 5.9 | 8.8 |
| 6½ | 5 x 5 | 6 x 6 | 197 | Four | 8.2 | 4.9 | 14.6 | 11.4 | 3.6 | 7.1 | 10.6 |
| 7 | 5 x 5 | 6 x 6 | 213 | ⅜-inch | 7.6 | 5.3 | 15.8 | 10.6 | 3.8 | 7.7 | 11.5 |
| 7½ | 5 x 5 | 6 x 6 | 228 | round | 7.1 | 5.6 | 16.8 | 9.9 | 4.1 | 8.2 | 12.3 |
| 8 | 5 x 5 | 6 x 6 | 243 | rods | 6.6 | 6.0 | 18.0 | 9.2 | 4.4 | 8.8 | 13.2 |

TABLE II—DIMENSIONS OF CONCRETE CORNER POSTS, AND MATERIALS NEEDED

| DIMENSIONS | | Weight of posts in pounds | Amount of reinforcing metal required for each post | PROPORTIONS AND AMOUNTS OF MATERIALS | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 Cement, 3 Sand | | | 1 Cement, 2 Sand, 3 Pebbles or Stone | | | |
| | | | | No. posts per barrel cement | For 1 Post | | No. posts per barrel cement | For 1 Post | | |
| Length in feet | Size in inches | | | | Sacks cement | Cu. ft. sand | | Sacks cement | Sand cu. ft. | Pebbles cu. ft. |
| 8 | 6 x 6 | 288 | Four | 5.6 | .7 | 2.1 | 7.8 | .5 | 1.0 | 1.6 |
| 8 | 7 x 7 | 392 | 7/16-inch | 4.1 | .95 | 2.9 | 5.7 | .7 | 1.4 | 2.1 |
| 8½ | 7 x 7 | 416 | round rods | 3.9 | 1.0 | 3.1 | 5.4 | .8 | 1.5 | 2.2 |
| 8 | 8 x 8 | 512 | Four | 3.1 | 1.3 | 3.8 | 4.4 | .9 | 1.8 | 2.8 |
| 8½ | 8 x 8 | 544 | 9/16-inch | 3.0 | 1.35 | 4.0 | 4.1 | 1.0 | 2.0 | 2.9 |
| 9 | 8 x 8 | 575 | round rods | 2.8 | 1.4 | 4.3 | 3.9 | 1.1 | 2.1 | 3.1 |
| 8 | 10 x 10 | 799 | Four | 2.0 | 2.0 | 5.9 | 2.8 | 1.4 | 2.9 | 4.3 |
| 8½ | 10 x 10 | 850 | 11/16-inch | 1.9 | 2.1 | 6.3 | 2.6 | 1.5 | 3.1 | 4.6 |
| 9 | 10 x 10 | 899 | round rods | 1.8 | 2.2 | 6.7 | 2.5 | 1.6 | 3.2 | 4.9 |
| 10 | 5 x 5 | 250 | Four 3/8-inch | 6.4 | .6 | 1.9 | 9.0 | .4 | .9 | 1.4 |
| 12 | 5 x 5 | 300 | round rods | 5.4 | .7 | 2.2 | 7.5 | .5 | 1.1 | 1.6 |

smoother finished post can be produced and the molds, if duly cared for, will be much more durable than homemade ones. Larger posts, such as corner posts and gateposts, are generally cast in place, because of their weight, and wooden forms are erected in the excavation made for the purpose. The accompanying tables give sizes of posts and suitable reinforcing, as well as quantities of materials required.

Round rods are preferable to other forms of reinforcing for concrete posts, principally because this type of steel is most easy to obtain. Barbed wire and other scrap material used as reinforcement will not give such satisfactory results.

Sometimes a 1:2:4 mixture is used for concrete posts. This is all right, if the materials are very well graded and the concrete is mixed to proper consistency and very carefully placed; but a 1:2:3 concrete is better, because it will help to compensate for improperly graded materials and, being richer, will be more certain to bond securely with the reinforcement, if the concrete is placed right in the molds. Square or rectangular posts are in more common use than those of other shapes.

For fence posts, a little more water may be used in the mixture than is required to produce a quaky consistency. When placing concrete in the forms, it should be stirred by runnning a stick or rod along the edge of the form and by tapping or jarring the mold so as to cause the concrete to settle thoroughly to all corners and around the reinforcement, releasing air bubbles that may be in the mixture.

For ordinary line posts, coarse aggregate should not exceed half an inch in greatest dimension. Larger aggregate than this will make the concrete hard to place with respect to thoroughly surrounding the reinforcing rods. Unless these are thoroughly surrounded by good dense concrete, moisture will get at them and, if rusting starts, bursting of the concrete will follow. Good, rich concrete will prevent this, because it has been proved that steel can be indefinitely prevented from rusting by imbedding it in good concrete. If mixtures used for concrete posts are of the right consistency, it is usually possible to remove the form from the post or the post from the form in 24 hours after placing concrete. No attempt should be made, however, to move the post until it is several days old. Cracks once opening up while the concrete is green will always remain and cause weakness.

After posts are a week old and have hardened under a covering of wet hay or straw, they may be set outdoors to finish hardening. They should not be used until they are at least 30 days old. What has just been said about fence posts applies literally to clothes-posts. Gateposts and corner posts can be made of a 1:2:3 concrete in which the aggregate may be as large as three-fourths inch in greatest dimension.

Fittings for hanging gates should be cast in the post when the concrete is placed, pro-

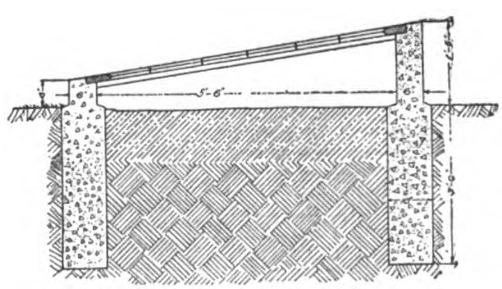


**Fig. 430.** A concrete hotbed is permanent, insect- and decay-proof, attractive and much more able to keep the heat in and the cold out than any temporary wooden structure.

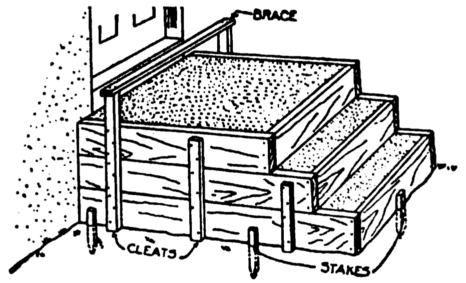



FIG. 431. A concrete walk and back steps keep muddy feet and many severe colds out of the house; they are both actually easy to make.

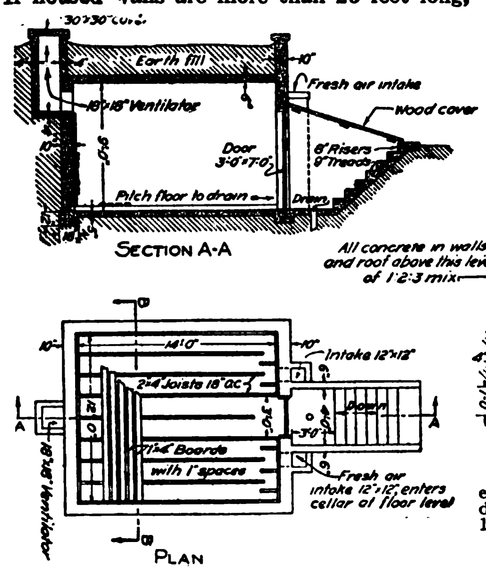
vision being made in the form to hold such fixtures in proper position. Gateposts and line posts should not be used until they, also, are at least 30 days old.

**Hotbeds.** Concrete makes permanent hotbeds. Any farmer who has had to replace the old wooden hotbed or cold-frame every year or two knows what this means. Excavation for hotbed walls should extend below possible frost penetration. Below ground the wall may be from 8 to 10 inches thick, but above it need not be more than 5 or 6 inches. No footing is necessary for hotbed walls.

If any one stretch of wall extends no more than 25 feet in length, reinforcement in the wall itself is not necessary; but reinforcing rods, 4 feet long and not less than one-fourth inch in diameter bent to the form of an "L" with each leg equal in length, should be embedded at the corners, to prevent cracking from changes in temperature as the result of expansion and contraction of the concrete. If hotbed walls are more than 25 feet long, they should be reinforced throughout, or there should be provided at every 25 feet a joint in the concrete that will permit of contraction and expansion. This joint may be filled with some kind of tarred felt.

A 1:2½:4 concrete mixture is good for hotbed walls. If well spaded when placed in the forms, no surface treatment or finish will be necessary beyond that given by contact of the concrete with the forms.

**Concrete steps.** Concrete steps for the cellar or for the side or front porch are much preferable to wooden ones. To build steps and side walls for the cellar entranceway at one operation requires complicated forms; it is therefore, customary to build steps and side walls, or ramps, as they are called, separately. Either can be built first. A riser must be laid out just as in the building of wooden stairs, so that the number of steps necessary may be determined. Excavating must then be done until this riser sets at the right slope to bring the treads of steps level. The soil must be well compacted and must be excavated far enough back of the forms to permit at least 4 or 5 inches of concrete where the riser and tread join. It is often best to lay reinforcing rods in this backing, to help prevent the cracking. One-quarter-inch round rods, 8 to 10 inches apart, will be sufficient. A 1:2½:4 concrete may be used both for side walls and steps. If any difficulty is encountered in smoothing the treads or steps, this can be overcome by having ready a little 1:2½ sand-cement mortar to apply under a wooden float while finishing the treads. After the forms have been removed, if there are any imperfections in the work, these can be easily pointed up with sand-cement mortar.



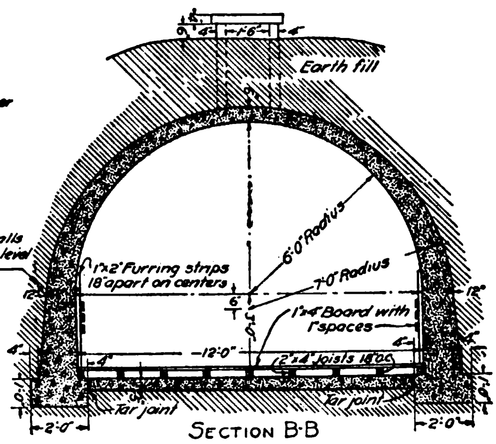




FIG. 432. A root and fruit cellar that is frost-tight, economical of space and materials, and a means of bringing down the cost of living. It requires 45 barrels of cement, 14½ cubic yards, sand and 22½ cubic yards of pebbles.

# CHAPTER 26

# General Repair Work on the Farm

*By* PROFESSOR R. P. CLARKSON *(see Chapter 14). One of the advantages of farm life is its independence. But this very independence makes necessary a certain self-reliance, an ability to look after one's self and one's belongings in emergencies. The making of repairs and the doing of odd jobs about the farm are illustrations of the application of such ability. This chapter mentions but a few of the possible tasks, listing the tools necessary for their accomplishment; it should, however, suggest some of the many directions in which a farmer may develop his efficiency.*—EDITOR.

EVERY modern farmer should have a good kit of tools and know how to use them. By so doing he may save many times over the value of a great deal of delay and frequent repair bills during a single season. Not only is it advisable to have the tools from the standpoint of making repairs, but, also, the possession of good tools often stimulates a man to use his spare time in working up various handy devices and arrangements about the house and barn.

**Tools required.** It is always difficult to pick out a list of tools required for any work so varied as that on the farm. There are certain essential ones, but the owner of a good kit acquires them gradually as the need is anticipated, and learns to know each separate tool, its value and its limitations.

In general, hand tools are sufficient for most of the work, provided a good blacksmith's forge is included. The materials worked on are almost always either wood, iron, or steel, or concrete, wood unquestionably predominating. Means must be provided to cut and shape these materials, to smooth them for easy handling and nice appearance, to repair them when fractured or bent, and to cover them with a protective coating when needed. Means should also be provided to connect together several pieces of the material, as with bolts, screws, nails, etc. To accomplish these things, the following tools should be acquired:

### For Working in Wood

A cross-cut saw for cutting across the grain of the wood.
A keyhole saw for sawing interior holes in boards.
A rip saw for cutting with the grain.
A back saw for fine sawing as in cabinet and joinery work.
Several chisels for making joints, mortising, etc.
Several gouges for slotting, rounding corners, fluting, etc.
A wooden mallet for use with the chisels and gouges as well as for striking wood without marring.
A claw hammer for driving nails and pulling them out as well as for use in striking metal, etc.
A T-square for laying out work carefully.
A carpenter's level for plumbing and leveling.
A plumb line for erecting perpendiculars.
Carpenter's dividers for laying out circles.
A brace with several sizes of bits for boring holes; also a screw driver fitting the brace, for handling very large screws or screws in hard wood.
Small and large screw drivers.
A hand plane for planing up boards.
A jack plane for smoothing up the end grain.
A marking or scratch gauge for laying out parallel edges and lines in marking out work.
An awl for starting nails and screws, etc.
A rasp for smoothing up rough work.
A counter set for sinking screw heads.
An adze for shaping up rough work.
A draw shave for spokes and round work.
An ax.
A hatchet.
A putty knife.
Glue and brush.
Sand paper for finishing.
Assorted wire nails.
Assorted screws. (Beware of brass screws in hard wood, they twist off easily.)
A 2-foot folding rule.
A knife.
Several paint brushes.
Lumber crayons.
A bottle of shellac.
Carpenter's pencil.
Oilstone for whetting tools to a keen edge.
A grindstone for roughing tools to an edge.
An emery wheel for heavy grinding on tools and for bringing other material to shape.

The cost of all of the above tools and materials of good substantial quality will total about $35. It will pay to get the best steel in all cutting tools and to keep the tools always sharp, well-oiled and carefully placed in a tool chest or closet. A well-oiled tool will not rust, so it is a good plan frequently to

wipe each tool with an oiled rag. Another sure way to prevent steel from rusting while laid away, is to dip it while warm in a solution of washing soda and then allow it to dry without handling.

### For Working With Metals

The main purpose of any metal-working tool outfit is to enable the farmer to make necessary changes and repairs in his machinery. Tools desirable are:

A bench vise for holding material.
Copper vise jaws to hold pieces without scratching them or cutting their surface.
A hack saw for cutting metal, rods, pipe, etc.
Two dozen assorted blades for hack saw.
Two or three flat files, fine and heavy cut.
A rat-tail file.
Two or three triangular files for notching, sharpening saws, etc.
A ratchet drill for drilling any metal in place.
Assorted drills—size for tapping holes.
Centre punch for marking drill starts.
Ball peen hammer, machinist's style.
Riveting hammer, very light.
Set of taps with holders, for threading holes.
Set of dies for threading rods and pipe.
Soldering outfit with instructions.
A small bicycle wrench.
Two or three cold chisels.
An 8-inch and a 16-inch monkey wrench for nuts.
A 12-inch Stillson wrench for holding pipe.
A pair of wiremen's heavy pliers.
A pair of gas pliers.
A pair of heavy shears.
A gasoline torch for soldering and for thawing pipes, melting lead for joints, etc.
A small hand forge for welding metals, bending metal, and simple blacksmith work.
Blacksmith tongs.
Cutting chisel for metal.
A pair of iron or steel bench clamps.
Shears for cutting sheet metal.
Heavy blacksmith hammers.
Assorted bolts and nuts.
Several dozen assorted copper and soft-iron rivets.
Assorted lag screws.
Emery cloth.
Cotter pins.
A few odd pieces of pipe and metal rod.
Washers.
Some sheet tin, brass and copper.
6-inch calipers for measuring diameters.
A 12-inch steel scale.
A scratch awl for marking metal.
Some white chalk for coating metal so that scratch marks may easily be seen.

The above materials should cost about $60 for good-quality tools and materials, provided only small sets of taps, dies, drills, etc., are purchased.

A liberal allowance for a complete wood and metal-working outfit as listed above, including a tool closet or chest, would be $100. Such an outfit would enable a man to make or repair almost anything of metal or wood provided no machine work was required. In most cases, especially repair jobs, nothing more than skilful hand labor is needed.

## The Use of Tools

There is a wide difference between the use and the abuse of tools. No tool should ever be used for a purpose for which it is not intended if such use tends to have an injurious effect on its quality or ability to do its work. Tools are expensive and each one is entitled to receive proper care, and careful use, to be regularly oiled and sharpened when in service, and to be carefully stored when not in use. Every cutting tool should be sharpened after continued use so that it will be in proper shape when next needed.

### A Few Don'ts

Don't use a wrench as a hammer.

Don't use a Stillson wrench on nuts.

Don't use a cross-cut saw to cut with the grain.

Don't use nails for permanent work under strain or twist—use screws.

Don't expect a tool to stay sharp forever without grinding as well as whetting.

Don't take anything apart until you thoroughly understand how it works.

Don't try to bend and work metal when it is cold. Better heat it, even in a bonfire or kitchen stove.

Don't be afraid to tackle any reasonable task—common sense and good tools will go a long way and save you money. Besides that, you are learning something by doing the work.

Don't be afraid to write to manufacturers, your farm paper or the agricultural colleges. You can get good advice and suggestions gladly given without cost.

### Metal Working

**Repairing cast iron.** The main purpose of the blacksmith forge is to prepare metals: (a) for bending steel and iron to shape; (b) entirely changing their form by hammering; (c) cutting heavy metal; (d) welding broken parts together. Cast iron does not lend itself to any forge treatment. It is brittle, does not bend without breaking, and does not weld at all under forge temperatures. It may, however, be welded by a blow torch with the oxyhydrogen or oxyacetylene process or by electrical methods. The cost of thus getting broken cast-iron frames, flywheels, and similar parts mended is less than the cost of similar new parts. With proper skill in mending, the strength of the weld should be even greater than the previous strength of the

piece. More important now, however, is the fact that the delay in waiting for a new part is avoided.

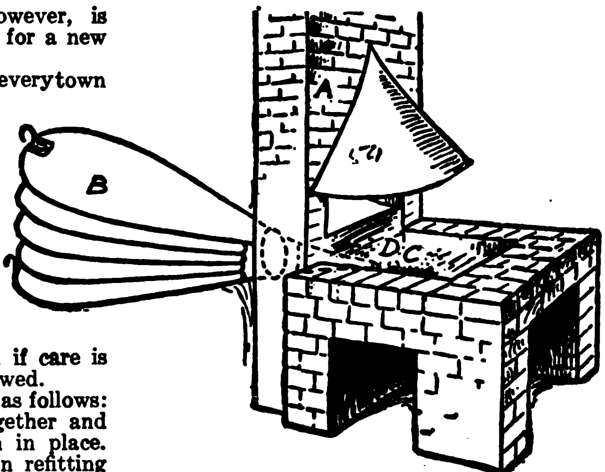



FIG. 434. Handy portable forges can now be bought very reasonably; but where this is impossible such an affair as shown here is efficient, cheap, and easy to make.

There are welding shops in almost every town and city of any size, usually in connection with machine shops or automobile garages and repair plants. A small welding outfit for home use will cost $50 and upward, depending upon how extensive a set of tools is selected. Of course, with such an outfit in hand, it is possible to pick up considerable repair work on surrounding farms and thus make the outfit pay for itself. The work is simple and quite easy for any man, if care is taken and directions carefully followed.

The process employed is usually as follows: The parts are carefully fitted together and arrangements made to hold them in place. They are then marked to guide in refitting them. The edges are beveled to make a sort of reservoir, and the torch applied to them together with the welding strips of iron metal. This metal melts, the fractured faces of the pieces become molten, and the whole mass fuses and welds together at the melting-point temperature. This process purifies the cast iron more or less at the point of welding, with the result that it is better and stronger metal, less brittle than the cast iron itself.

**The use of the forge.** One of the first essentials in forge work is a proper fire. It must be bright, with a good forced draft that can be applied at will, usually by means of foot or hand bellows. For the best work a good grade of coal is required, although almost any soft coal may be used if the gases are burned off before the metal is put in the coals.

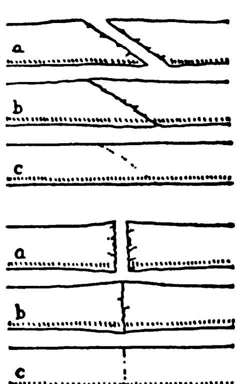



FIG. 433. Three stages in lap welding (*above*), and butt welding (*below*): *a* the ends roughly shaped then upset; *b* the fresh, enlarged weld; *c* the weld hammered down to the size of the rest of the bar.

Shavings are usually used for kindling. A bucket of water should always be handy to sprinkle around the fire and keep it confined to a very small area. A good forge fire for most work can easily be covered with a dinner plate.

For bending metal, heat it to redness and reheat whenever the color fades. In shaping-up metal it should be brought to a very bright red—almost a white heat, and should not be worked after the color has come down to dark red, or a poor job with cracked edges is likely to result. For welding, a white heat is required. The metal should be "spitting" fire, but great care should be taken not to burn the iron—that is, don't heat it so far that it is consumed. Where at all possible, the weld should be made (as it almost always can be) in one heat.

For welding the metal must be clean and at a welding heat; and it must be struck sharply by the hammer. The first blow of the hammer tells the story. That blow should do most of the welding and should be struck where the metal is thinnest because that is where it cools quickest. Some practise should be had before attempting work on any important piece. Make the practise weld, allow the metal to cool and then bend it with the hammer right at the weld. If the weld separates it is usually because the metal was either not clean or not hot enough. To be sure of the part being clean it is best to jar it on the anvil before striking it with the hammer.

In a lap weld, the two pieces are tapered so that, when joined, they will be slightly larger than the main part of the piece. Then after welding they can be reduced by hammering. Round rods are usually joined by butt welding; that is, the ends to be welded are "upset" or made bulky by previous heating and hammering on the end. They are then brought to welding heat and driven together endways by a sharp hammer blow.

**Drill work.** A good ratchet drill will drill any thickness of metal and any size of hole up to perhaps 3 inches in diameter or more, by hand. It costs less than $10 and weighs only 2 or 3 pounds, being very simple in construction. It can be used anywhere to drill holes without having to take the machine apart, if

the ratchet can be braced. It can also be used as a bench drill by means of clamps with which to fasten the work.

In drilling metal use oil freely. It lubricates and keeps the drill cool, and prevents the loss of its temper and hardness particularly on the cutting edge. Lard oil is good for wrought-iron drilling. For cast-iron drilling, the graphite in the iron furnishes lubrication so that water can be used for cooling. Unless care is taken, however, this will result in rusting the iron. Machinists, therefore, usually mix soda with the water, using the solution freely.

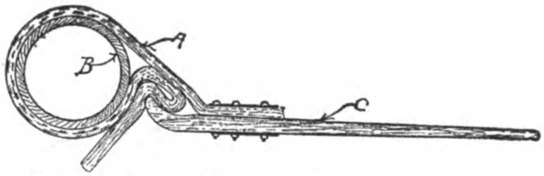



FIG. 436. When a Stillson wrench of the right size is lacking, this emergency affair will often make up or loosen refractory unions. B is the pipe; A is a heavy strip of canvas or belting: C is a tough piece of hardwood to which A is firmly bolted.

**Tapping and threading.** The same rules apply to cutting threads as to drilling. Both are cutting processes and require care for the sake of the tool as well as of the result to be accomplished. Don't force the cutting tool. Cut light chips. Be careful not to bend or break the cutting instrument. It is always brittle because of its temper and can easily be broken by carelessness.

If a tap is broken in the hole, heat the piece and frequently the tap can be withdrawn. If not, drill into the tap with a small drill, drive a square shaped piece of steel lightly in the drill hole and turn with a wrench. Sometimes the tap will have to be drilled out to the size of the original hole and the shell of the tap left pried out with a cold chisel.

**Sheet-metal work.** The working of sheet metal is an art in itself but by taking time almost anything desired can be made by means of shears, a wooden mallet, a straightedge, and a soldering outfit. It is best for an inexperienced man first to make a paper pattern cut to the shape of the part desired and then to fold, bend, or roll this pattern with edges overlapping to the finished shape to be sure it meets the requirements. Then lay the pattern flat and mark the sheet metal to exactly the same shape. Mark on the metal the bending lines of the pattern and in every way make it agree with the tried-out paper pattern. Then cut out the metal with shears. Bend straight lines by laying the straightedge on the bending line and hammer the metal with the mallet against the edge. For rolling to shape use a piece of pipe or a log to bend the metal around. With odd or complicated shapes, cut out a piece of wood to hammer the metal against. Overlap the edges and fasten temporarily with clamps, rivets, bolts or even by nailing through into a strip of wood on the inside. Then solder, and after cooling, remove the temporary fastening if desired.

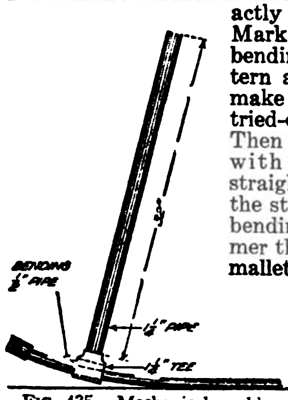



FIG. 435. Mechanical problems on the farm are varied and unusual and call for special tools. A pipe bender can be made of a strong tee with a pipe handle screwed into it.

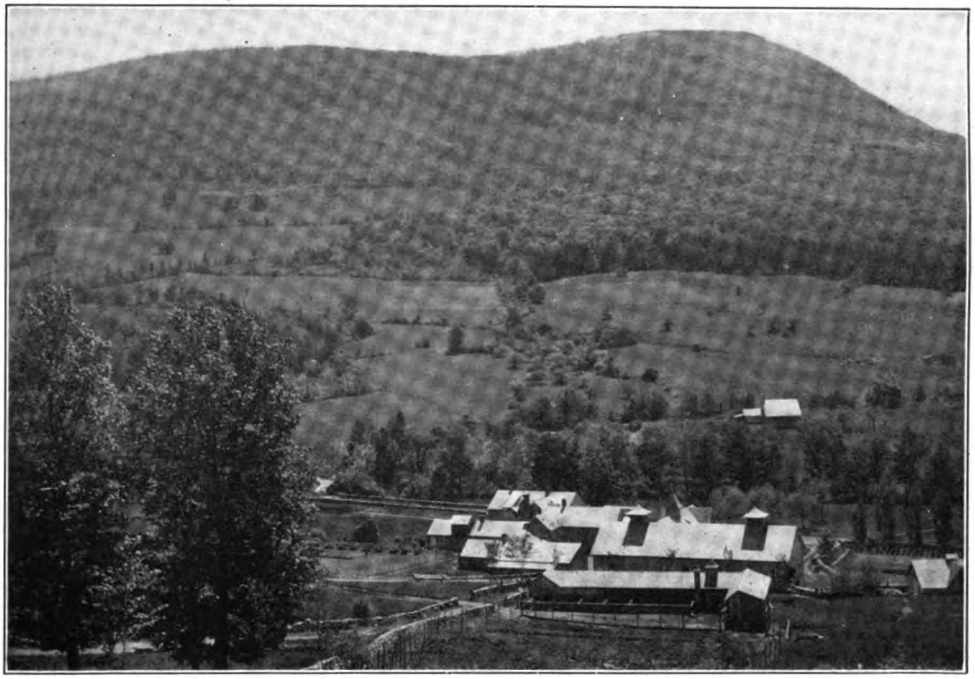
**Patterns for casting.** Patterns may be made of wood, metal, concrete, plaster of Paris or any material which can be finished reasonably smooth. These patterns are taken to the foundry, sand is molded around them, the patterns are withdrawn and the molds filled with the molten metal. The resulting shape is then just like the pattern. Broken parts can be mended temporarily and used as patterns in getting new castings. Complicated parts to be cast require special knowledge of the foundry processes in order that the patterns may be made so that they can be withdrawn from the mold without breaking up the sand.

Frequently it is possible to make patterns by forming a mold with sheet metal or cardboard and pouring in wet plaster of Paris. This fills the mold and gives a solid pattern to the shape of the mold. This solid pattern can then be used in the foundry for a few castings, though it is not a good permanent pattern. Concrete or mortar can be used in the same way, of course, but takes much longer to harden.

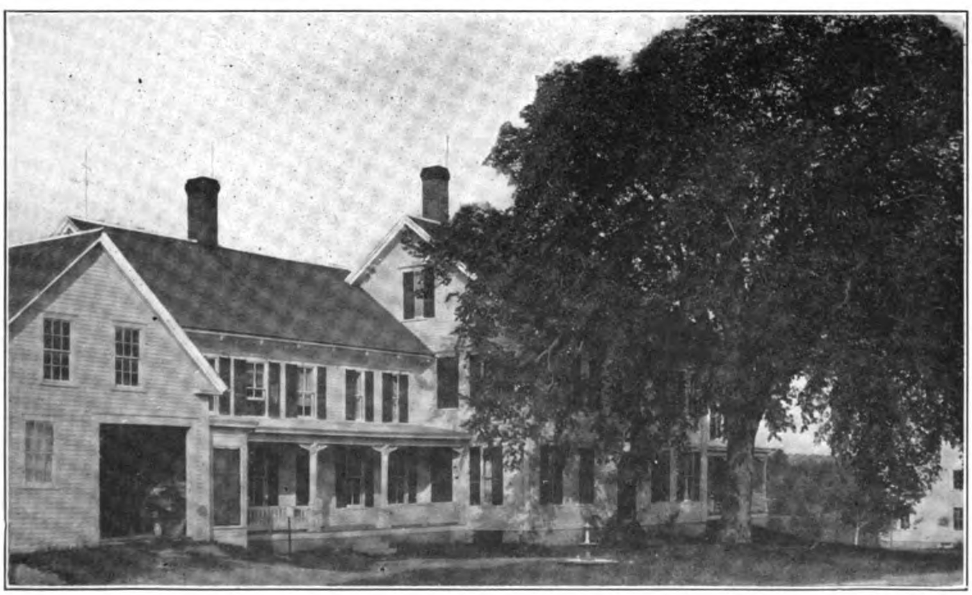
## Carpenter Work

In all work with wood, study the grain of the piece and work with the grain as far as possible. Otherwise no marked lines can be followed, the wood will split on the grain, and the piece will be spoiled. Cut lightly and often. Don't attempt to break off a piece until it is sawed or cut through completely. Don't use sandpaper except to give a light smoothness to the finished pieces, and do that with the sandpaper wrapped around a good block of wood. Neither sandpaper nor emery cloth are cutting tools for shaping; both are finishing tools.

In all work mark out the piece completely and keep outside the lines so that the completed piece will show the part of the lines along the edges. For fine work the lines should be cut lightly with a knife and pencil marks should not be used at all. For rough work use a carpenter's pencil or a lumber crayon.

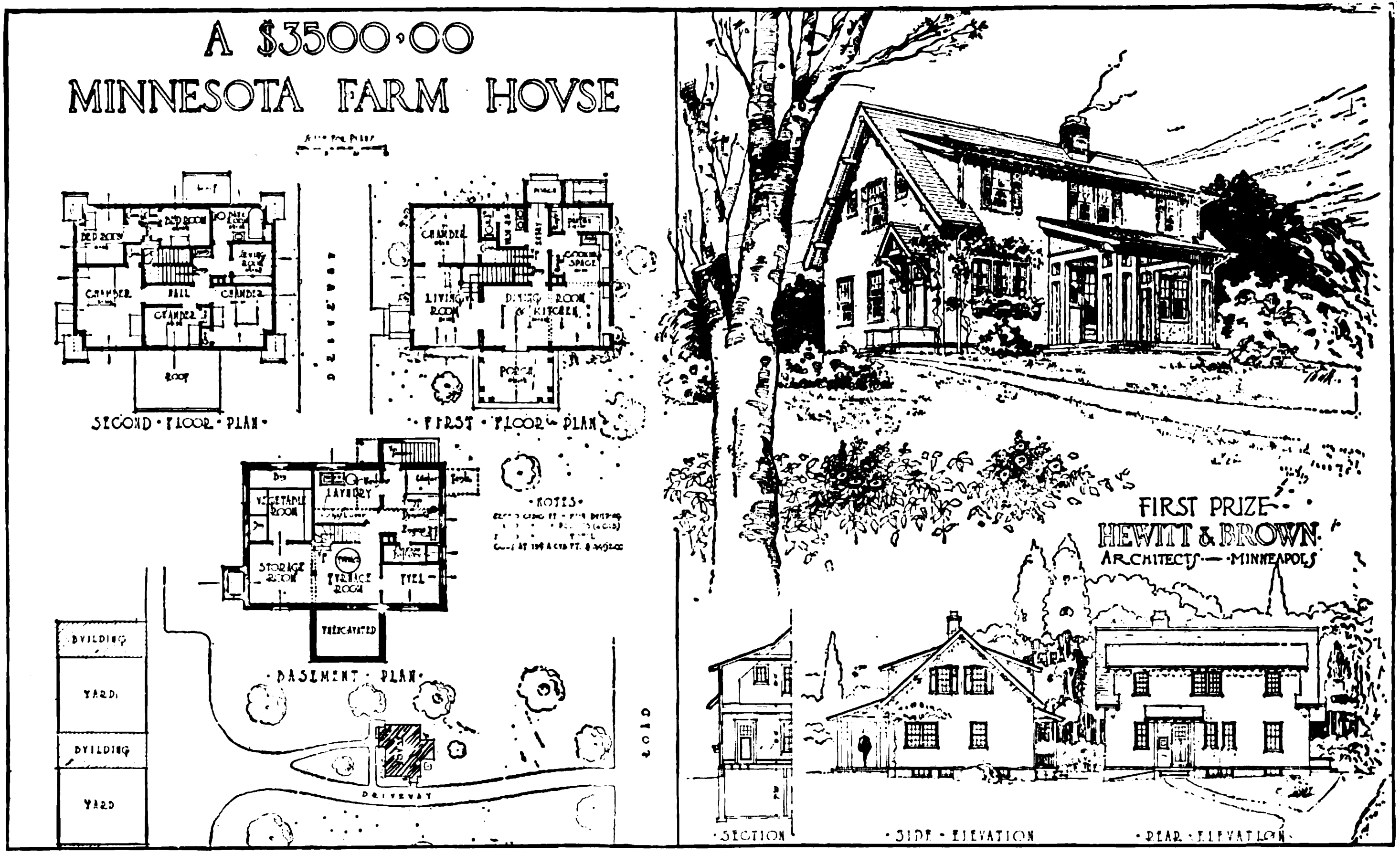


The farmstead is the hub of the farm; it should both dominate the fields that surround it and receive its inspiration from them



The first purpose of a farmhouse is to shelter the farm family; it should, therefore, be an attractive home in all that the name implies

THE FARM IS BOTH A HOME AND A PLACE OF BUSINESS. THE DWELLING ESPECIALLY SHOULD MEET BOTH NEEDS




*Reproduced by courtesy of the Society*

**Design and Plans of a Low-priced Farmhouse That Won First Prize in a Competition Held Under the Auspices of the Minnesota State Art Society**

## Paints and Paintings

The coming of spring should be a signal for painting everything that needs it, whether house, barn, fence, or machinery. Particularly should machinery be looked after and, emphasis cannot be too strongly laid on this point, for few things are so neglected as machinery on the ordinary farm. Not all paints are of equal value for these different jobs. What is good for iron is not good for concrete, and the paint which is so satisfactory on the house may be of little value for the wagons. A paint for woodwork consists of some dry material for coloring, a lead or a zinc base, a drier, and a vehicle or liquid. It is the vehicle which is often wrongly chosen, and in some ready-mixed paints, the vehicle is the part which is most likely to be adulterated. For outdoor work, except decorations, boiled oil is considered to be the best. For indoor work, linseed oil and turpentine are preferably used. A little drier, litharge for dark paints, and sugar of lead for light paints, should be added to each batch of paint mixed.

Undoubtedly linseed oil paints are more expensive than others, but they are well worth the difference in price. This oil enables the paint to spread well, dry hard and opaque, and leave a protecting skin over the wood surface. If adulteration is practised with resin oils, mineral oils, or fish oils, the paint will either remain sticky forever or will harden quickly only to soften again in a week or 10 days. Particularly should dark-colored paints be looked upon with suspicion unless purchased from a thoroughly reliable dealer, because such paints when cheap usually contain only unrefined resin oils which soften up within 2 weeks of the first drying. Thereafter they never harden again but continue to give constant trouble.

One of the best paints for roofs and machinery is a mixture of red lead and linseed oil. Another good metal paint is known as asphaltum varnish. It may be purchased ready for use, and when applied leaves a splendid-wearing shiny black surface which thoroughly protects the metal.

For painting jobs requiring the covering of a large surface, the paint may usually be sprayed on with much less labor than if the application is made with a brush. Almost any paint may be so applied if it is made thin enough. Use the ordinary spraying apparatus kept for orchard spraying and occasional disinfecting or whitewashing. It may be readily cleaned and will suffer no injury from such use. Probably whitewash is more often applied in this way than any other paint. Particularly in covering fences and out-buildings the spraying method means a great saving in time. Yet ordinary whitewash is not as economical as cement whitewash for it requires frequent renewals, while the cement wash often remains satisfactory even several years' wear. The combination is best made in the following proportions: Mix together one peck of white lime, a peck and a half of hydraulic cement, 6 pounds of umber, and 4 pounds of ochre. Slake the lime first, mix it with 2 ounces of lampblack moistened with vinegar, then add the other ingredients. Allow the paint to stand for 3 hours or longer, stirring occasionally. The addition of half a pound of Venetian red renders the appearance more pleasing and adds to the value of the paint. If ordinary whitewash is used at all, the addition of a little glue or a small amount of flour mixed with boiling water and poured in while hot will prevent it from rubbing off so readily.

For finished interior work, varnishes are best. They give an extremely hard surface, which protects the wood beneath, and they are easy to clean thoroughly. It is not advisable for any one but an expert to attempt to mix them at home, for many good ones are on the market, as well as many worthless mixtures called varnishes. True varnish is a solution of resins or gums in some suitable liquid such as alcohol or oil of turpentine mixed with linseed oil. Those in which alcohol acts as the solvent are spirit varnishes and are inferior in many ways to the oil varnishes, chiefly because the alcohol evaporates entirely, leaving the varnish so hard as to easily crack and chip. The oil varnishes, on the other hand, should never get brittle.

## Repairing Floors and Foundations

**Repairing old flooring.** Often it is desired to cover old floors or, with the installation of bathroom fixtures in the house, to make a waterproof floor. For this latter purpose the various modifications of Sorel stone are highly recommended. Its strength and hardness exceed those of any artificial stone yet produced; at the same time it is one of the cheapest. For stable and stall floors it is also of considerable value, for it is sanitary, easy to clean, and wears well.

There are almost as many different varieties as there are users of the stone, for every one makes some little change in the details of mixing. The fundamental thing is to mix in with the various filling substances an

"oxychloride binder" which is nothing more or less than a solution of magnesium oxides and chlorides. This is used to moisten the filling substances in the same way as water is used in concrete work. The fillers may be almost anything—shredded wood or cloth, sawdust, asbestos, sand, ashes, pebbles, etc. You may buy the material all ready for use from any large paint shop or hardware store and do the work yourself, or you can get any of the companies selling the substances to do the work for you. You may, if you like, mix the ingredients and make your own stone.

If you buy the material ready to use, you will get two packages. In one kind, the packages contain powders which must be mixed together after which water is added. In the other kinds of composition, one powder and one liquid are purchased and the two are mixed. In either case, the mixture is made somewhat stiffer or thicker than ordinary cement and is spread on the old floor, or on the flooring built to receive it, to a depth of half an inch. The surfacing must be well done and not left rough. It will "set" over night and will then be hard enough to walk on but the floor should not be really used for 3 or 4 days. Probably several months will elapse before the floor reaches an even color all over. From time to time it will be necessary to remove the white blotches caused by the chemical action going on in the floor material, by simply washing them. After a time the floor will be stone hard and, of course, fireproof and waterproof. This latter characteristic is a highly desirable one, for almost all other artificial stone, in common with brick and concrete, is very porous and open to the absorption of water. Any desired color may be added to the composition, the earth colors giving the best results.

Although this flooring has not long been receiving the attention of private builders, it is not a new thing. There are hundreds of patents for different mixtures, and one kind or another has been used on the floors of railroad cars, in public buildings, and similar places for at least 20 years. Recently some of the important patents expired, and since 1908 as many as 50 companies manufacturing composition have come into existence.

The ingredients of and methods of mixing one of the best compositions are as follows:

50 parts (by weight) of calcined (burned) magnesite.
15 parts of dolomite (marble dust).
5 parts asbestos (shredded).
15 parts sawdust.
2½ parts silicate of magnesium.
11 parts of earth colors.

Mix the above powder very thoroughly and add a mixture of equal parts of water and chloride of magnesia until the proper consistency is obtained. Frequently, to make a better union of the elements, the above powder is added to 1½ parts of muriate of ammonia.

In another composition flooring the materials are mixed at the shipping point, the receiver or user adding simply water and burned or calcined magnesite. In this the specific materials are:

85 parts magnesium chloride solution.
36 parts of any filler such as sawdust, ashes, etc.
25 parts of infusorial earth or fossil flour.
Add to the above:
100 parts of pulverized burnt magnesite.
43½ parts of water.
Desired coloring material as red oxide, ochre, etc.

All of these substances are cheap. The mixtures as retailed by manufacturers cost about 15 cents per square foot of floor surface for the substance and an equal amount for doing the work. Unless you are willing to take great pains with the laying and finishing of the floor, an expert should be allowed to do it.

By using the above mixture but substituting large pebbles or stones for part of the filling material suggested, a first-class concrete is obtained. The same mixture, also omitting the filling material and coloring matter, and adding the proper sand or sharp, small stones, may be used for the formation of grindstones, emery wheels, etc.

**Stopping leaks in concrete.** If old work is to be protected, surface coat-

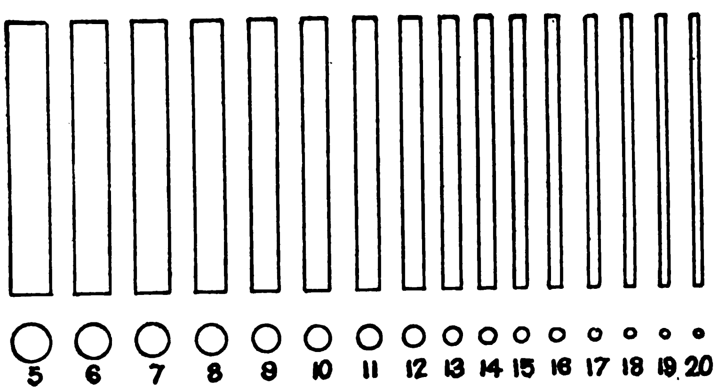



FIG. 437. Wire is a most important article in farm construction and repair work. These are the commonly used sizes shown lengthwise and in cross section, actual sizes. Of course the strength and stiffness of any size depends upon the material of which it is made.

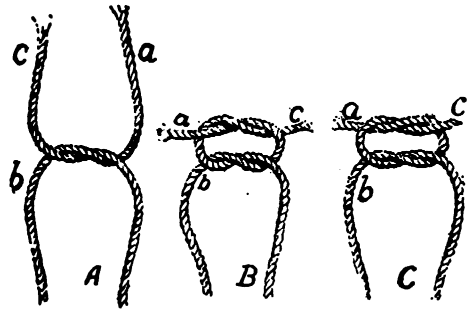



FIG. 438. A knowledge of how to use rope is a fundamental need in farm repair work. This shows how both the granny knot (*B*), which is insecure and unreliable, and the square knot (*C*), which is safe and efficient, start the same way (*A*).

ings only can be used, their object being to fill the pores already referred to. Four substances are commonly used for this, namely: neat cement, asphalt, paraffin, and an alum-soap compound. This last is used in what is known as the Sylvester treatment, and is one of the most effective. For surface coating a hot castile soap solution is made by dissolving three quarters of a pound of the soap in one gallon of hot water. An alum solution, of one half a pound of alum to 4 gallons of water, is then prepared. The substances are thoroughly dissolved and applied alternately to the wall which must be perfectly dry. The hot soap solution is first applied with a flat brush, care being taken to avoid leaving bubbles. After this coat dries for 24 hours, a coating of the alum water is put on and allowed to dry for a similar length of time. In this way, alternate coatings to the extent desired may be used, allowing a full day to elapse between each two coatings. A chemical process takes place between the substances used, the resulting compound plugging up the pores in the cement. The cost of this process, including two coatings of each material, will be from 35 to 40 cents per square yard.

Paraffin, although rather expensive, is often used for small jobs. It may be melted and applied while hot, the walls also being slightly warmed, or it may be dissolved in some solvent such as benzol, xylol, or even benzine of the common kind, these liquids quickly evaporating. Several coatings will be needed, and each coating will cost in the neighborhood of 50 cents per square yard.

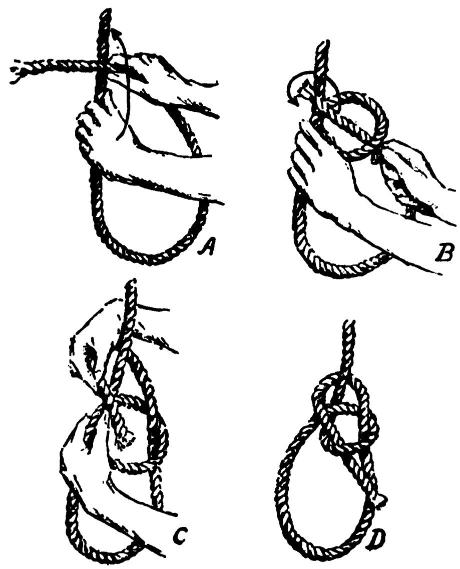



FIG. 439. The four steps in making a bowline or non-slipping loop—a most useful knot for both sailors and farmers.

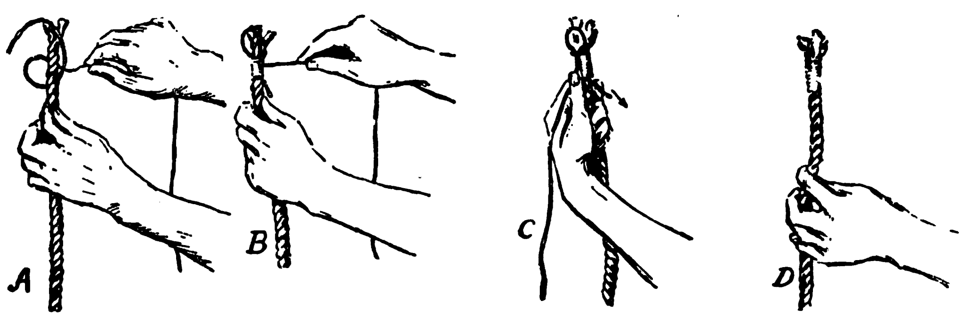



FIG. 440. The end of a rope, like that of any worthy task, should be well finished. This shows how to whip a rope's end so as to prevent raveling and at the same time avoid a bulky knot

# CHAPTER 27

# Dynamite and Its Uses on the Farm

*By* J. H. SQUIRES, *Agronomist and Editor of the E. I. duPont de Nemours Co., Wilmington, Del. Before he took up this particular line of work he had several years' experience with the U. S. Department of Agriculture. Previous to that he had been student and assistant in the Agricultural College of New York at Cornell University and Professor of Agronomy at the New Mexico Agricultural College, and has made a personal study of the agriculture of all parts of the United States. His training has therefore included the practical farm point of view as well as the study of the chemical, physical, and purely agricultural problems that confront the agricultural scientist. In common with many large commercial enterprises and organizations, the manufacturers of explosives have progressed far along the road of supplying accurate information and practical assistance to all who request them. It is with a knowledge of this condition in mind that we can heartily subscribe to Mr. Squires's further suggestion, as follows: "In many cases the uses of explosives are somewhat complex, either as regards the loading or the firing. Unfortunately, the amount of specific literature available on this subject is not as great as might be desired. When confronted with a difficult proposition, the safest procedure is for the amateur blaster to take up the matter by correspondence with some one of the leading manufacturers of agricultural explosives or a local professional blaster to whom he may be referred by the company consulted."*—EDITOR.

WHILE some black powder is used for different purposes on the farm, the chief agricultural explosive is dynamite. This is packed in round, paper-covered sticks or cartridges measuring about $1\frac{1}{4}$ inches in diameter and 8 inches in length. Each such cartridge weighs about half a pound. While there is a large number of kinds of dynamite and similar explosives made for general use, only a few are especially adapted for the farm. The commonest of these are: (1) the low-freezing extras and nitro-starch grades, for general work; and (2) straight nitroglycerin dynamite, for blasting ditches in wet soils without a blasting machine and for mudcapping very hard boulders. Dynamite is packed in wooden cases containing either 25 or 50 pounds net and is sold by the pound.

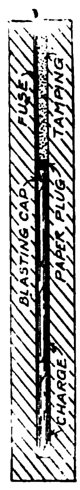



FIG. 441. A paper plug is sometimes used between charge and tamping.

**What dynamite is.** The modern dynamites differ materially from those manufactured a few years ago. In appearance they resemble fine sawdust that has been slightly moistened with oil. Most dynamite is really fine wood pulp which has been allowed to absorb varying amounts of nitroglycerin or some other explosive compound. When exploded, dynamite is changed from a solid to a gas having a much larger volume than the original explosive. It is the pressure of this gas that does the work. If the gas is allowed to escape easily out of a bore hole, the amount of work done by the blast is materially reduced, so all holes should be carefully tamped to confine the gas.

**Tamping.** By tamping is meant the confining of the charge in the bore hole made for loading. This is done by first packing a few inches of moist soil lightly over the charge, and then filling the rest of

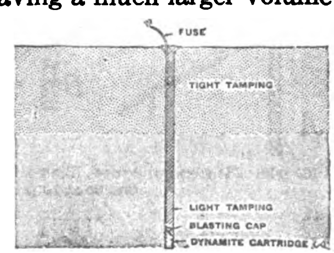



FIG. 442. A charge properly tamped, lightly at the bottom, tightly above

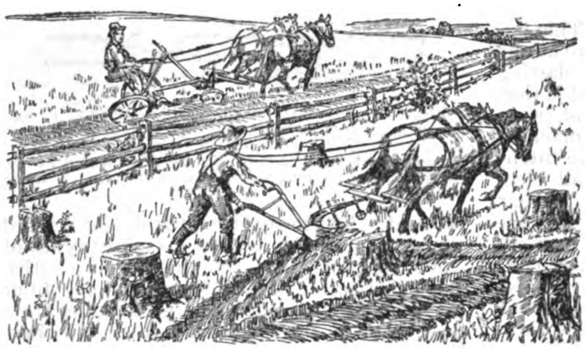


FIG. 443. One way in which dynamite can reduce the wear and tear on the machinery, the teams, and the physical and mental strength of the farmer. It has been estimated that every stump in a cropped field takes a toll of from 25 to 50 cents. At this rate the use of dynamite soon pays its cost.

the hole and packing it solidly. The few inches of light tamping act as a cushion to protect the charge from shock, so the rest can be forced in as hard as possible, using a wooden stick, such as an old hoe handle, in one hand. For mudcaps (p. 452) the mud placed over the charge acts as tamping and should be as heavy and thick as possible to better confine the explosive action. The force exerted by exploding dynamite is equal in all directions and works just as hard in an upward as in a downward direction.

**Keeping explosives on the farm.** While dynamite is a high explosive, it can, with reasonable care, be used on the farm with no more danger than attends a great variety of farm operations. It is sent from the manufacturer to the buyer by freight thus receiving rougher treatment in transit than is ordinarily given it in use. The law requires that it be removed from the freight station within 48 hours after its receipt. In hauling dynamite care should be exercised to guard against any unnecessary roughness, and against danger from fire. Explosives should not be hauled in the same vehicle with either blasting caps or electric blasting caps. The boxes should be protected with blankets or similar covering, to afford additional safety.

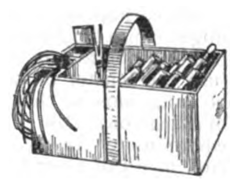


FIG. 444. Take with you at any time only as much dynamite as you will use. Carry caps and fuses in separate compartments

When stored on the farm, dynamite should be kept in a dry place, such as a little-used or isolated house, where it will be safe from the weather, and from meddlesome persons or animals. Thus stored it can be kept in perfectly good condition for a considerable length of time. When large amounts are kept constantly on hand, a special bullet-proof, weather-proof house or box should be provided.

Blasting caps require the same storage conditions, being quickly affected by moisture; but should never be stored with any kind of explosive. Fuse may be stored or hauled with either dynamite or caps, as it is not explosive; however, it must be kept dry. Neither caps nor dynamite should be stored in a blacksmith shop or in any place where there is danger from sparks.

### Principles of Farm Blasting

Only the required amount of explosive should be taken to the scene of work at any one time. It should be handled as gently as possible, and by painstaking workmen.

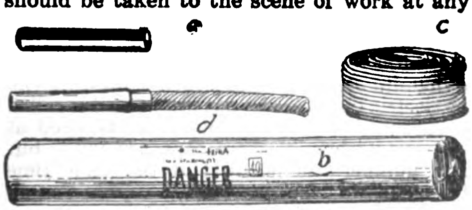



FIG. 445. What does the work. *a*, blasting cap; *b*, stick of dynamite; *c*, roll of fuse; *d*, cap crimped to fuse

For farm dynamiting in which caps and fuse are used, the tools needed are few and, usually, on hand. A crowbar or thick drill is useful for punching holes in nearly all kinds of blasting. A 1½- or 2-inch auger with a long shank is good for both sampling soils and making holes under stumps and boulders, and for deepening drilled or punched holes. A cap crimper is needed for crimping the caps to the fuse. A tamping stick is easily made from a sapling or a broken tool handle.

In electric blasting, for the removal of large stumps and boulders, or for ditching in dry

soil, a blasting machine is needed. This apparatus is made in different sizes to fire at one time different numbers of electric blasting caps. The smallest one recommended is that firing 10 charges; on the other hand, sizes larger than the 30-charge capacity machine are seldom needed except in extensive ditching work. These machines are small electric generators and are long-lived. Their cost is small as compared with their advantages in making it easier to do better or more difficult work. The electric current is conducted from the blasting machine to the blast by two 14 gauge copper wires enclosed within a single insulation. This double wire, if well cared for and kept straight, will also last for a long time. It should be not less than

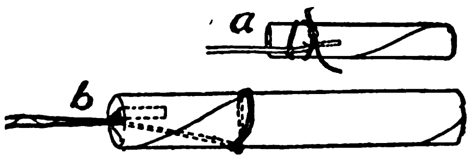



FIG. 446. Fastening the cap to the cartridge. *a*, blasting cap and ordinary fuse; *b*, electric cap and wires

250 feet long to enable the blaster to work at a safe distance from the blasts.

All curious or unnecessary onlookers who might cause trouble should be kept away from blasting operations; otherwise they may confuse the blaster or do something that might be dangerous for themselves or others. Farm blasting has now progressed to the point where many expert blasters are devoting a part or all of their time to it. By obtaining the advice and assistance of a competent blaster one can often effect a considerable saving in the amount of explosives used or improvement in the quality of the work done. One of the noticeable misuses of explosives by both beginners and experienced users is the loading of excessive charges for any given amount of work. By careful loading, the amount of dynamite used can often be reduced and with it the total cost of the work.

There are several distinct classes of dynamite, each of which is manufactured in different strengths, which are expressed as percentages. Thus they vary from 20 to 60

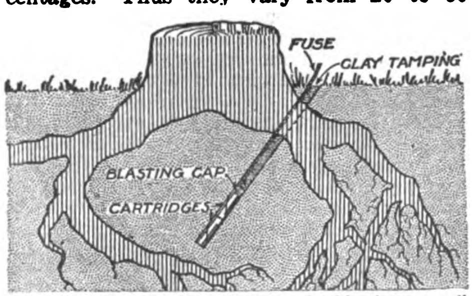



FIG. 447. Usual placing of charge for blasting a small stump

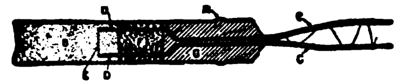


FIG. 448. Section of an electric blasting cap: *a*, copper shell; *b*, chamber containing explosive; *c*, copper wires (insulated); *d*, bare ends of wire in charge; *e*, "bridge" or fine wire joining ends of (*d*), which is heated by the electric current; *f*, plug to hold wires in place; *g*, filling material.

per cent. The lower strengths should be used whenever possible, as they do many types of work cheaper than the higher strengths. The substitution of the 20 per cent for 40 or 50 per cent grade in blasting stumps from heavy soils is proving economical. The low-freezing classes of dynamite are to be recommended for all farm work except blasting ditches without a blasting machine, and mud-capping hard boulders.

The use of dynamite on the farm, although it involved more than 25,000,000 pounds in 1917, is yet in its infancy. There is still much experimental work to be done before either the full benefits or the definite limitations of farm blasting are determined. Blasting is not recommended as a general "cure-all" for the farm, but as a specific treatment for a number of adverse conditions.

## Practical Blasting Methods

Unlike black powder, dynamite is not fired or "detonated" by means of a spark, but by an intermediate agent, such as an explosive blasting cap or an electric blasting cap. The former is a little copper cylinder, closed at one end, and charged with a small amount of a powerful explosive. It is fired by means of safety fuse, which is a small chain of powder tightly enclosed in a strong covering. In use, the fuse is cut long enough to reach from the buried explosive to a few inches above the ground. It is not safe to use short pieces of fuse, as they do not give the blaster sufficient time to get a safe distance away after lighting the blast. The blasting cap is fastened securely to the fuse (Fig. 445*d*) by means of a special tool called a cap crimper. A hole is then punched in the side or end of a cartridge of dynamite, into which the cap with fuse attached is inserted and securely tied (Fig. 446.)

An electric blasting cap is more elaborately constructed and is fired, not by a fuse, but by an electric spark brought to it through small wires. It may be placed in the dynamite in exactly the same way as the blasting cap, or secured by a special loop (but *not* a half-hitch) of the wires (Fig. 446). A dynamite cartridge into which a blasting cap or electric blasting cap has been fitted is called a "primer." Only one blast can be fired at one time when blasting caps are used, but any number can be fired at the same time by means of electric blasting caps. For all classes of agricultural blasting one primer is sufficient for each charge, no matter how

FIG. 449. Making a hole for a charge under a stump with a soil auger

many cartridges are used in the hole; but with the single exception of ditch blasting by the propagated method (p. 302) every type requires this one primer in *every* charge or hole.

**Stump blasting.** For the removal of stumps, dynamite is used with cap and fuse as well as with electric blasting caps. For small stumps (Fig. 447), and for the large stumps of the Pacific Coast, a hole is punched well under the heaviest part of the stump and loaded with the required amount of dynamite, which may vary from one to many cartridges. Blasting caps and fuse are generally used in this case.

Large or hollow stumps, especially those with spreading roots, are best blasted by distributing charges, one under the stump and others under the main roots (Fig. 450). This method requires the use of electric blasting caps so that all the charges may be fired at exactly the same time. Tap-rooted stumps present two possibilities: (a) A hole may be bored into the tap root and loaded as in the case of a small stump (Fig. 447); or (b) two holes may be punched on opposite sides of the tap root (Fig. 451), loaded, and fired at the same instant by means of an electric blasting machine.

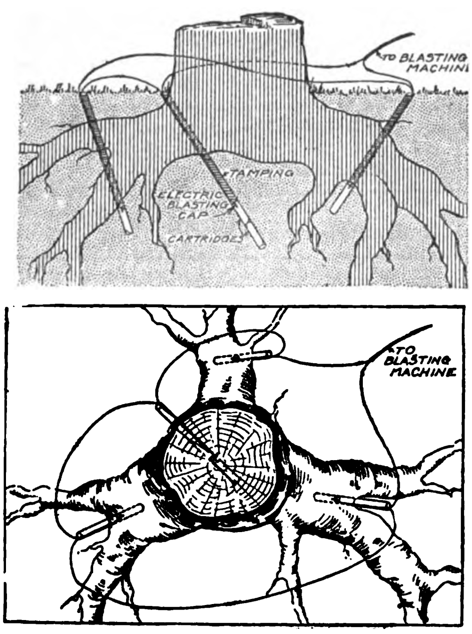



FIG. 450. Distribution and connection of charges for blasting a large stump with spreading roots; viewed from the side (*above*) and from the top (*below*).

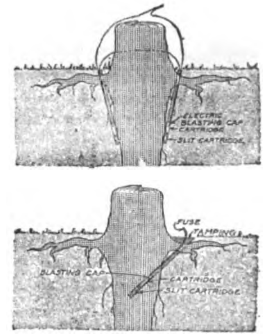



FIG. 451. Two ways of distributing charges under a tap-rooted stump.

Many variations are made in these methods of loading stumps to suit local soil conditions and the nature of the stump to be removed. Large amounts of dynamite are used in connection with stump-pulling machinery for splitting stumps before or after pulling. This combination method is especially satisfactory in heavy clearing. For splitting before pulling, a single hole is generally used and the charge materially reduced as compared with that required for blowing the stump entirely out. Trees may be blasted down by following the rules given for loading for stumps, but the amount of explosives must be considerably increased.

**Boulder blasting.** For breaking up and disposing of field boulders, dynamite is used in three ways: (a) mudcapping, which consists of placing a charge of dynamite on top of the boulder and covering it with a heavy cap of mud, (Fig. 452), requires the least labor, but the largest amount of explosives; for very hard boulders the use of the higher strengths of dynamite is recommended. (b) Snakeholing, which consists of punching a hole in the ground under the boulder (Fig. 452), requires a medium amount of both time and labor; the low strengths of dynamite prove best. (c) Blockholing, which is loading a hole drilled into the boulder (Fig. 452), requires the greatest amount of labor and the smallest amount

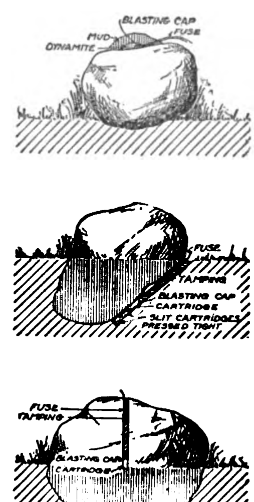



FIG. 452. Three ways to blast a boulder: from above, mud-capping snakeholing; and blockholing (see text).

FIG. 453. Large boulder, such as often interferes with tillage, ditching, or tree planting, before (*left*) and after (*right*) the explosion of a mud-capped charge of dynamite. It is now good foundation material in addition to being out of the way.

of explosives; the low strengths are more economical. Combinations of the mud-cap and snakehole methods are frequently used for large boulders. The method em-

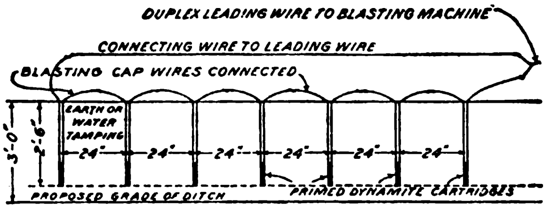



FIG. 454. Diagrammatic section showing how to place and connect up a series of charges in blasting a ditch

ployed should depend on the nature of the boulders encountered. Flat, easily broken boulders can be handled by the first method; large, difficult ones may require the last method.

**Ditch blasting** provides a new method of digging ditches and one that has proven successful under a great variety of conditions. There are two methods: (a) The propagated method, which can be used only in water-soaked soils, consists of punching holes to about the desired depth of the ditch and loading each with one or more cartridges of 50 or 60 per cent straight nitroglycerin dynamite. The soil must be saturated and the holes not more than 24 inches apart. A line of holes many feet long, when properly

FIG. 455. A surface outlet ditch dug with dynamite

loaded, is fired by a single primer, usually placed near the centre of the section. (b) The electrical method differs in that it can be used in either wet or dry soil. Lower strengths of low-freezing explosives are used, and an electric blasting cap in each hole. The holes can be spaced farther apart sometimes, in large ditches, as much as from 30 to 48 inches. For wide ditches two or three lines of holes are used. By this method ditches up to 6 feet deep and 15 feet wide have been successfully blasted. Blasts are frequently made in hard ground to loosen the ground to make digging by hand or scrapers easier. The application of ditch blasting to the straightening of streams has proven quite successful, as the work is quickly and economically done.

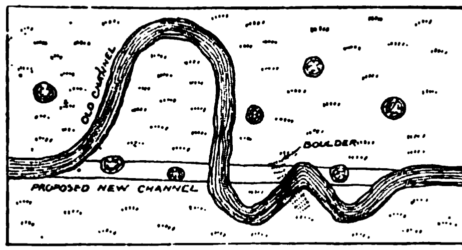



FIG. 456. A stream may be straightened and, incidentally, various obstacles removed from its new course, by means of dynamite.

Rafts and sandbars also may be blasted out of streams.

**Loosening the soil before planting trees.** The use of explosives in planting trees is recommended on tight and hardpan soils. Its purpose is to loosen the hard ground in such a manner as to permit: (1) better drainage and water storage; (2) better root growth; and (3) better soil aëration. The blasts are usually made with one fourth pound of a low strength, low-freezing dynamite placed at a depth of 30 to 40 inches or in the hardpan. A hole is made in the ground to the desired depth and loaded. The blast, in addition to cracking the soil, springs a pothole or cavity at the bottom (Fig 457), which must be filled with soil to overcome the danger of the tree settling after being planted.

This is usually done by emptying the hole and filling the cavity as shown in Fig. 458, which also illustrates the correct method of setting a tree, including the use of fertile top soil around the roots. Blasting in preparation for the planting of shade trees or flowering plants is done in exactly the same way as in the case of trees.

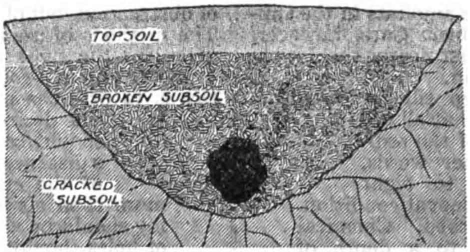


FIG. 457. In blasting before tree planting, the explosion loosens the soil, but also creates a pot hole at the bottom which, left unfilled, might injure the tree more than the other results could benefit it.

Summing the matter up, it may be said that the use of dynamite in the orchard accomplishes the following seven results:

1. It mellows the ground to a depth of 5 or 6 feet and throughout a circular area 10 to 20 feet in diameter, making it easy to dig the hole and plant the tree correctly.

2. It creates a porous, water-absorbing condition in the subsoil that makes the tree drought-proof, stopping the big, first-year loss.

3. It makes root growth easy and makes tons per acre of new plant food available, hence speeds up the growth of the tree and makes it fruit one to two years earlier.

4. It creates drainage and prevents stagnation of water on surface.

5. In old orchards that were planted by the old methods and have ceased to bear well, it is of great value in rejuvenating the old trees, causing them to yield heavily.

6. It destroys fungus, nematode, and other orchard soil diseases, hence makes it possible to plant new orchards where old ones have been removed without waiting several years to rest the land and get rid of the diseases.

7. At a cost little or no greater than that of old-style planting, it causes at least a year's earlier return on the investment in new orchards, and greatly increased returns thereafter as compared with spade-set orchards.

**Subsoil blasting.** This, like blasting for tree planting, is not recommended on loose or open soils, but only on tight clays or hardpan. Its purpose is to open and aërate the soil so as to afford a better moisture reservoir; to induce better soil sanitation; and to increase the possibilities of extensive root growth. The work is usually done in the fall when the soil is dry. The standard charge is one fourth pound of a slow-acting, low-strength dynamite. The holes are usually made from 28 to 40 inches deep and about one rod apart. Such subsoil blasting has also been used to good advantage as a means of loosening hill soils to guard against erosion. Deep subsoil blasting is practised, especially in the bottoms of ponds and other wet places, to break through the underlying hardpan and permit the excess water to drain away through still deeper layers of gravel or sand.

The duration of the benefits thus obtained is not as yet clearly worked out, but it appears from tests that they should be effective for a considerable number of years. So far they have been more marked during the second and third years after blasting than during the first. If proper attention is given to the surface it is quite unlikely that they will return to their former state within the life of man. When heavy, deep-rooted crops such as alfalfa, for instance, are used to supply humus and increase the supply of nitrogen, the deep roots left to decay in the soil will guarantee the permanency of the benefits. Planting of a deep-rooting crop should always follow subsoiling.

On sour, wet land, where the clay is very sticky, it will be found an excellent practice to use considerable amounts of lime in order to sweeten the soil and to assist in the formation of an ideal crumb structure. Do not blast subsoil while it is in the sticky state. No good will come of it.

**Blasting to assist drainage.** Aside from the benefits of explosives for shattering impervious subsoils as above described, this method of soil tillage finds ready application in shattering subsoils to assist other drainage methods that are not giving satisfactory results. Tight clays and hardpan soils where tile drains are found to function poorly and establish drainage courses slowly, if at all, are found to be greatly improved by shattering the subsoils between the lines of tile. The same is found to be true in soils that are but little affected by open drains, where the

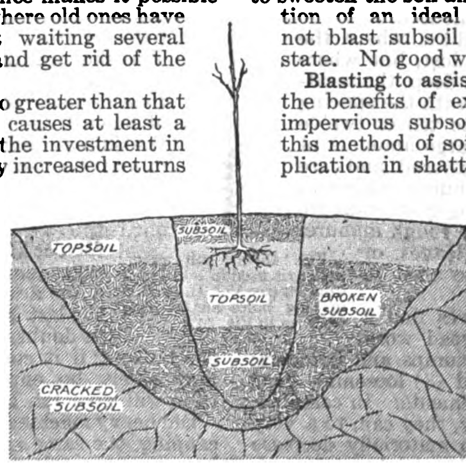


FIG. 458. To get the best results, therefore, dig out the centre of the loosened soil, fill in the pothole (enriching the subsoil with manure if possible), plant the tree, putting top soil around its roots, and firm all down securely. (Illustrations in this chapter, except Fig. 449, by courtesy the E. I. du Pont de Nemours Powder Co.)

water is held in too large amounts in the subsoil quite near the drains. Care, however, must be taken not to blast nearer than seven or eight feet to a tile drain.

The reason why deep tillage or subsoil plowing is desirable is that all the soil below the bottom of the ordinary plow cut, in other words, everything below six to eight inches, is still in its primeval condition. It has never been disturbed. Chemical analyses of soils down to a depth of twenty feet show that on the average acre there are tons of plant foods which become available only when roots can penetrate to them, or when ascending moisture brings them up to the roots that cannot get down.

**Gully filling.** This use of dynamite is for the purpose of blowing down the banks of the gullies so that the loosened soil can be easily dragged to the low places. Sometimes heavy blasts will throw much of the bank into the bottom of the old gully so that the earth will not require a second handling. The practice finds ready application especially in the southern hill lands. To correct for shallow washes, the deep loosening of the hard subsoil should extend out on each side for some distance.

If broken boulders, stumps, logs or any other loose material is placed in the bottom of the gully before it is filled the effect will be that of a deep, well-laid tile drain. Through this the excesses of water will be discharged without injury to the surface. In many cases, it will be well to straighten up the bottoms of the gullies and lay permanent subdrains before the filling is commenced.

For wide, shallow gullies, where the entire surface has been lost, but where the cutting has not been deep, the treatment is deep subsoiling with the spacing of the holes decreased to ten or twelve feet. In filling gullies large amounts of unaërated subsoil are exposed, and care should be taken to add humus either in the shape of rank-growing green-manure crops, vegetable litter or rough manure. Old corn stalks, forest leaves, or mildewed straw can be used to good advantage.

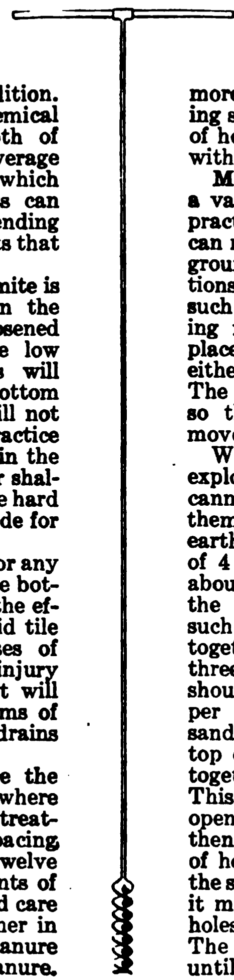


FIG. 458*a*. Soil auger, such as is used in taking soil samples (see Vol. II), and in making holes for blasting work as in Fig. 449.

**Road work.** Explosives find a ready place in general road work for: (1) clearing away stumps and boulders; (2) opening ditches; and (3) loosening hard ground for grade improvements. In combination with road machinery, they can, to a very large extent be made to materially decrease the amount and cost of hand labor required. This method finds application not only in the building of new roads, but in repairing and improving old roads. Blasting is a highly satisfactory method of getting many kinds of obstructions out of the way of the road drag. The methods of use are quite similar to those given for the same classes of field work.

In starting in a rock cut the ordinary practice is to drill the holes a few inches below the desired grade. These holes should be spaced back and apart a distance about equal to the depth of the cut, unless the holes are more than six feet deep, when the spacing should be about six feet. Each row of holes should be fired simultaneously with electric caps and a blasting machine.

**Miscellaneous uses.** Dynamite finds a variety of additional, special uses in practically all classes of farm work. It can readily be used for loosening up hard ground encountered in digging foundations, cellars, pit silos, and wells. For such work, modifications of subsoil blasting methods are used. The holes are placed much closer together and may either be deeper or more heavily charged. The object is simply to loosen the soil so that it can easily be shoveled or moved with a scraper.

Wells are often sunk with the aid of explosives through rock or ground which cannot be dug to advantage without them. When rock is reached and the earth above is properly supported, a circle of 4 or 5 drill holes should be started about half-way between the centre and the sides of the well and pointed at such an angle that they will come closer together near the centre when they are three or four feet deep. These holes should be loaded about half full of 40 per cent dynamite with damp clay or sand tamping packed firmly above to the top of the hole, and then exploded all together from the surface by electricity. This shot will blow out a funnel-shaped opening in the centre, and the well can then be made full size with another circle of holes drilled straight down as close to the sides as possible. If the well is large it may be necessary to drill a circle of holes between the inner and outer circle. The above process should be repeated until the well has passed through the rock or has been sunk to the necessary depth. Do not in any case enter a well until all the fumes of the last blast have come out. If in doubt, lower a lighted candle to the bottom; if it continues to burn the well may safely be entered. Electric blasting caps will give the best results.

Old heavy machinery can be broken by mudcapping, the same as boulders. Occasionally large iron vessels are broken up by being filled with water and shot by suspending a small charge of dynamite in the water in such a way that the explosive is not in contact with the metal.

# FARM KNOWLEDGE

## PART V

## Farm Buildings and Their Equipment

THE problem of locating, designing, constructing, and equipping his buildings is one of the most difficult that the farmer is called upon to solve. This, of course, implies that he is desirous of combining utility, moderate cost, and attractive appearance in the final result. In no respect is he more independent of outside influences and restrictions, than in his right to follow his own preferences as to style and arrangement. Presumably he has no near neighbors whose sensibilities he is either likely to offend or under any obligation to take into account. Farm houses are not built in blocks like city residences; their lines need not resemble one another nor even harmonize. The whole question resolves itself into satisfying himself and getting the most and the best for what he is able to spend.

However, there is another side to the matter. Whatever he may *think* he prefers, there remain those fundamental principles that have gradually been formulated after years of experiment and usage, as to what really is best, most efficient and most pleasing under average conditions. Only a genius is clever enough to disregard conclusions based upon the judgment of many generations; it is unlikely that any farmer is sufficiently a genius in architectural matters to be able safely to lay down new, unusual rulings as to how he shall plan and build. It is for this reason that farm buildings do, after all, resemble one another in the main, and often in most of their structural details. Because of this resemblance it is possible to set down, in relatively small space, a large amount of valuable information, suggestion and reference matter regarding them.

The chapters treating of this complex and very important department of farm engineering, are arranged in a definite, logical order: First, there is discussed the farmstead as a whole, its location and its arrangement; next, two chapters are devoted to the farm house, which after all is the most important building on the farm—probably no other worker spends as much of his time in the immediate neighborhood of the place where he sleeps and eats as does the farmer; the next two chapters deal with barns as a group, with reference, first, to their actual construction, and, second, to their equipment with labor saving devices; the remaining chapters treat the different classes of farm buildings as they may be grouped on a basis of purpose and usefulness.

It is no longer necessary, as it once was, for the farmer to hew his own timbers and pegs, split his shingles, saw out his lumber, and, with the help of his neighbors, build every barn and shed he requires from foundation to roof tree. Much and valuable assistance is now available in the form of manufacturers' coöperation and modern improved materials and methods. But it is still necessary for him to know what sort of buildings he shall erect; where and how they shall be erected; and finally, how to judge whether, when completed, they are what they should be. It is to help him to attain this knowledge that the following articles have been prepared and brought together.—EDITOR.

# CHAPTER 28

# Planning the Farmstead Layout

*By* H. H. NIEMANN, *Manager of the Architectural Department of the Louden Machinery Co., whose work is very largely the helping of practical farmers in all parts of the country toward the solution of their building problems. Most of his younger days were spent on the farm. About 1893 he took up architecture, specializing, since 1900, in the designing and superintending of farm structures. During this time he has laid out a number of well-known farms about Chicago, taking charge of the locating and construction of roads, drainage systems, fences, etc., as well as all the buildings. He has been in his present position since 1912; for a number of years he has also been a regular contributor on farm building construction to the "American Carpenter and Builder"; and for 3 years he has been on the Committee on Farm Structures of the American Society of Agricultural Engineers, serving as Chairman in 1917.*—EDITOR.

THE farm group, or farmstead, is a very important part of the farm, and deserves careful study as to its location on the farm, the buildings it requires, and the grouping of buildings, drives, and yards. The grouping of farm buildings cannot be standardized, because each farm has some special requirements which need individual study. A large number of rules may be suggested for such grouping; but, before any of them is applied, the following local factors must first be considered in connection with each farm: (1) climatic conditions; (2) topographic conditions; (3) soil conditions; (4) the type of farming; and (5) the kind of labor used.

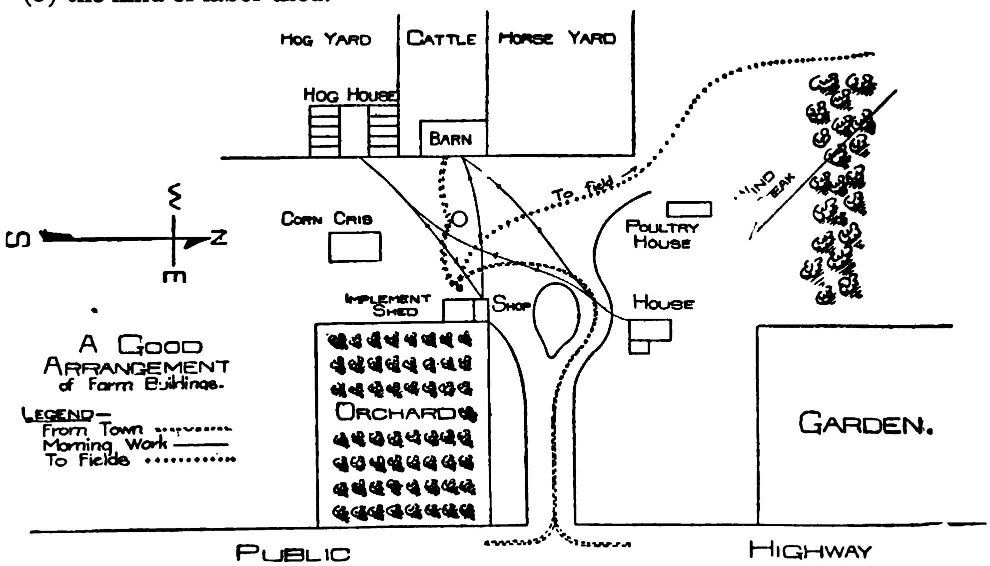



FIG. 459. A well-arranged farmstead showing the direct and comparatively few routes that have to be taken in doing the daily work. Compare with Fig. 460. (Both from Ia. Bulletin 126)

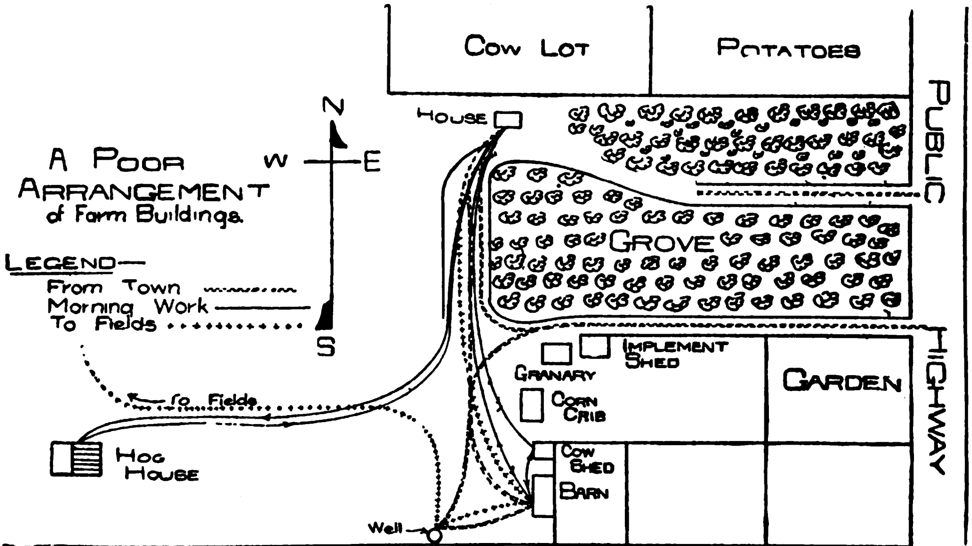



FIG. 460. Sometimes there are reasons for an apparently poor arrangement; more often they are the result of lack of thought. In either case they should be corrected as soon as possible. It is one thing to lose half an hour, unavoidably, once a month; it is another thing to lose half an hour every day the year round, especially when a little planning would prevent it.

## Local Factors in the Grouping of Farm Buildings

**Climatic conditions.** In the northern part of the United States, and particularly in the northeastern section, it is necessary to provide warm quarters for all livestock. These quarters must consist of substantial buildings, constructed to resist storm and conserve animal heat and must have adequate light, drainage, and ventilation.

In locations subject to deep snowfall, ample provision should be made to protect from snow, by covered enclosures, the passages leading from one building to another; and the buildings should be grouped as close together as their fire-resisting qualities will permit. In the central states, fewer precautions may be taken against snow. The farming is more diversified, and calls for a larger number of buildings, which makes grouping more difficult. In the Rocky Mountain region, the farm group will consist chiefly of stock shelters and small storage bins for grain. In the West, where the air is dry, more attention should be given to fruit-drying sheds, packing houses, granaries, etc. In the South, the equipment of buildings need not be so extensive. Special attention should be given to grouping the buildings on a high place where drainage is good; manures and wastes should be located at a greater distance from the group; and more attention should be given to protection against flies and other insects.

**Topographic conditions.** It is not advisable to locate the farm group between hills, for several reasons. First, because of "trapped air"; the group must have a free air current. A valley generally lacks air drainage as well as water drainage. Cold air will settle between hills. The night temperature in a valley is always colder than at a location where there is more circulation. Further, in warm weather, valley air becomes very sultry.

Second, because of difficult land drainage. Valley land is always the last to dry off after a storm and the last to thaw out in the spring. It will catch the largest amount of snow, and hold it longest.

Third, because of short days. The morning sun's rays are later in reaching the valley, and the evening rays are cut off earlier, making the days shorter, colder in winter, damper in spring, and warmer in summer, from lack of air circulation. In this respect, hills on the north and south of the group are not so objectionable as hills to the east and west.

The extreme top of a hill is the most healthful location for man or beast, but it sometimes has objections which should be considered. Storms are very severe, requiring special bracing in the construction of buildings; and windbreaks around the yards and stockpens are necessary. All feed and other supplies must be drawn uphill to their destination. The first objection may be overcome in the manner suggested, and the second is not serious, unless the hill is long and steep. On a prairie or slightly rolling country, the highest point on the farm is always the choice for the farmstead, provided its location is not too far from the centre of farm operations.

FIG. 461. A windbreak both protects and beautifies the farmstead

The advantages are long days of sunshine, good air, good drainage and, in most cases, good views of the farm.

**Hillside with southern slope the ideal location.** A hillside as the location for the farm group may be ideal or it may be objectionable, depending on the amount and direction of its slope. Just over the brow of a hill on the southern slope is an ideal location for the farm group, because it gives protection from cold storms, and is open to the sunshine.

A southern exposure for all buildings containing livestock makes an ideal condition, as far as climate is concerned, because here the ground dries out fast after a rain and the warm air currents are received.

**Soil conditions.** As the farm buildings, drives, and yards occupy a not inconsiderable space, which becomes unavailable for agricultural purposes, the question of soil should be considered. It pays to set the group a little farther away from the highway, if the land along the highway is more fertile than some other soil on the farm which has no objectionable features as to slope or location. Some of the barren spots on the farm, composed of soil which is not fertile, may also be objectionable for the yards, if it is of a dense nature that will not drain or dry out quickly; for example, clay or gumbo. These objections may be overcome by filling on top with sand, gravel, or cinders, after the surface has first been well tiled.

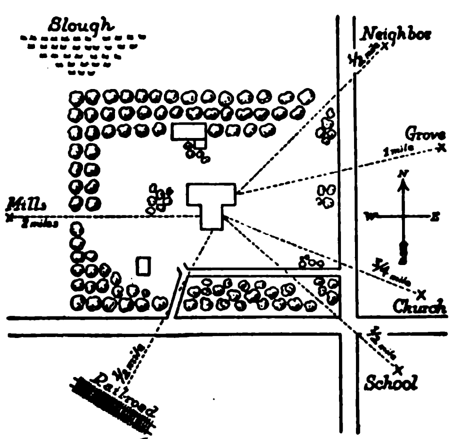



FIG. 462. The planting around the farmhouse should do at least three things: protect from severe prevailing winds; block out unsightly views; and frame the vistas that are beautiful or that tie the farm to its neighborhood and friends. (Ia. Exp. Station.)

**Type of farming.** The type of farming that is to be done will affect the kind and number of buildings more extensively than their location, although, the more diversified the farming, the more centrally the buildings should be located.

A stock or grain farm may have the farm group at one corner, or at the centre; but where the farming system includes dairying, grain, meat stock, gardening, and small fruit, the location

must be very carefully studied with a view to the elimination of unnecessary fences, drives, etc.

**Kind of labor used.** On the small farm, where most of the work is done by members of the family or by permanent help, housed in or near the residence, the buildings may be grouped closer to the house, with all walks, as far as possible, covered with shelter roofs. Where the work is done mostly by temporary labor housed in isolated tenement houses, all the barns may be located farther away from the residence; but the labor headquarters should be near enough to the barns for the chores to be conveniently performed.

## The Site and the Buildings

After noting the foregoing requirements and applying them to your particular farmstead problem, carefully considering the slope of the land with relation to drainage and exposure, and the position of the site in regard to the highway and market, it will not be difficult to decide whether your farmstead shall face north, east, south, or west. Topographic and soil conditions should determine the proper location; the type of farming will then determine the number of buildings required; the size of the farm will determine the size of the buildings; and the value of the land and its permanence for farming purposes should determine the type of construction.

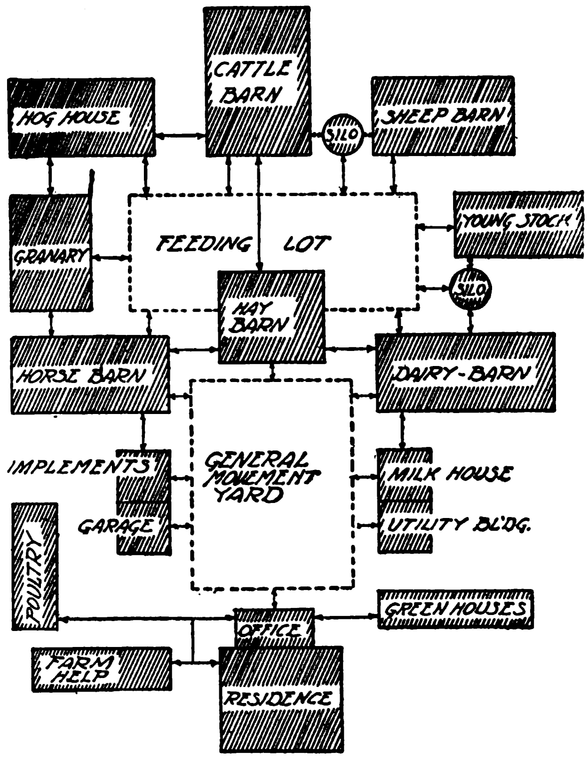



FIG. 463. Ideal arrangement of the farmstead on a large, general farm. A smaller enterprise would permit the combining of some of these buildings with a corresponding additional saving of time and steps.

A farmstead designed for a south front is not practical for a north front; neither is one designed for a west front practical for an east front. The compass points must be in the mind's eye from start to finish. They should be considered in grouping the buildings in proper relation to one another, in the proper facing of each building, and in the planning of its interior arrangement.

To place the buildings properly, the first consideration should be their relation to one another and to the farm in general. Farm routine and convenience to drives, fields, and highways should also be studied. Fig. 463 serves to illustrate, by means of the arrows, the relative connections of the buildings with one another. In determining their respective locations, the suggestions offered in the following paragraphs should prove useful. It is, of course, impossible to tell how any one farmstead should be arranged without carefully studying its problems. The aim should be to come as near as possible to the ideal arrangement outlined.

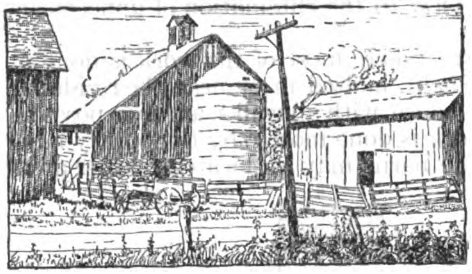


FIG. 464. This is not a very attractive view. If the farmhouse looks out only upon such scenes, either it should be moved and rearranged, or the farmyard and buildings should be made more pleasant to look at.

**The residence.** This should always remain the most important building of the group. Its location should be slightly higher than that of any of the other buildings and should afford a supervising view of the farm.

With regard to the highway the residence should be beyond the dust zone, which, in some localities, has been estimated to extend 650 feet north, 65 feet south, 250 feet east and 320 feet west of the highway. The residence should have a good view of the highway and of other points of interest. Its location should be such that prevailing winds will carry barn odors away from the house.

**The general-purpose barn.** The small farm, where only a few head of each kind of livestock are kept, does not justify separate buildings for the various purposes, but all stock (except, perhaps, the chickens and hogs, which have separate sheds), feed, and grain are placed in one barn.

The location of this barn should be very central, on well-drained land, and with convenient access to and from the house, fields, pasture, highway, and feeding yards.

It should be so placed with relation to the compass that all livestock may have the maximum of sunshine and the best of protection from winter storms.

**The dairy barn.** This barn, in which is produced the most nutritious of food for human beings—a food which is, however, the most susceptible to contamination and foreign odors—should be considered the most important barn on any farm where dairy products are produced. It need not always be the most expensive, nor the largest barn in the group, but it should have the choicest location with relation to drainage, air circulation, sunshine, and everything pertaining to its sanitation. It should have, also, convenient access to the hay and feed barn, silo, exercising yards, and milkhouse. It is advisable to keep the dairy barn isolated from all other barns containing livestock.

**The horse barn.** Until the power tractor shall have entirely displaced the work horse, provision will have to be made for the latter among the buildings on the farm. The horse should be housed in a barn which may also contain feed bins, hay storage, bedding storage, etc. The location of the horse barn should be selected with reference to convenience to the general yard, implement and vehicle shed, cultivated fields, highway, exercise yards, and granary.

**The cattle barn.** The barn for beef cattle, dry stock, and young stock should be located adjacent to a roomy feeding lot, so that the stock may freely enter or leave the barn as they choose, when the weather will permit. It should have large sliding doors on the south, and should form a good windbreak and shelter on the north of the feeding lot. A cattle barn is not complete without a silo, which must be convenient to the barn and feeding yard.

The construction of the barn and hay racks should make the feeding as nearly automatic as possible.

The foregoing remarks relating to the cattle barn apply also to the sheep barn.

**The granary.** The granary is a very important building on most farms, and its location should be studied with the view of having it convenient to the lanes leading to the grain fields. It should be convenient, also, to all barns containing livestock, and to the feeding lot. Its contents being very valuable, it should be far enough away from other buildings to prevent loss by fire. Sunshine and fresh-air circulation are very necessary.

**The hoghouse.** Where hogs are kept in connection with cattle, the hoghouse should be so located that the hogs may be turned into the cattle-feeding lot and allowed to pick up all the food which the cattle would waste. Also, the hoghouse should be quite near the corn-crib, for convenience in winter feeding, and should have sunshine and good air circulation. The location should also be such that prevailing winds will carry the odors of the hoghouse away from other buildings, especially the milkhouse, dairy barn, and residence.

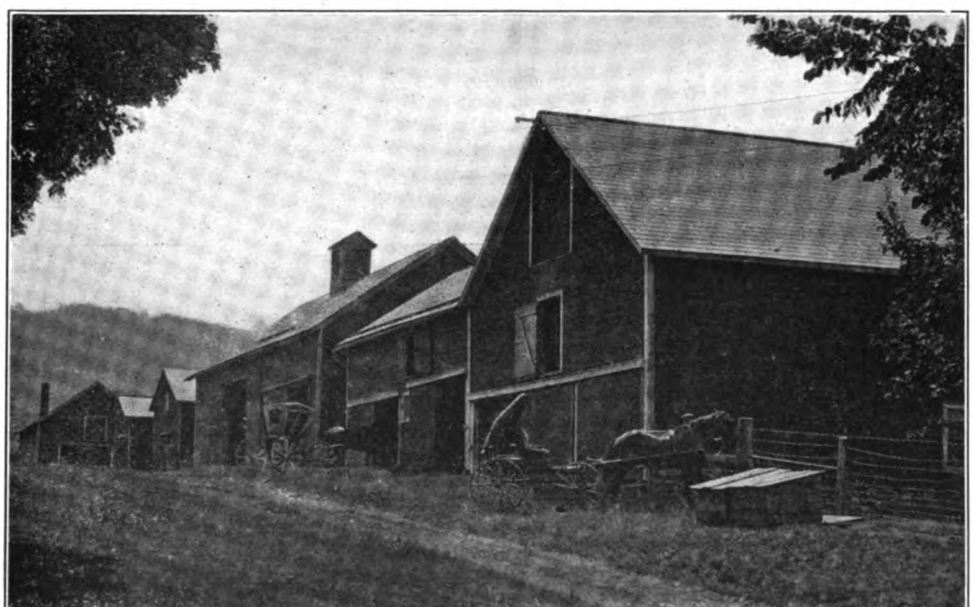
**The poultry house.** The poultry buildings of most farms are sadly neglected, because they are built with the idea of making possible the existence of a few hens, which may, to a greater or less extent, aid the housewife with her daily menu, through the supply of a few eggs and an occasional fryer.

The very fact that the poultry plant of the farm is, in most cases, turned over to the women folks to look after, is sufficient reason why its location and convenience should receive careful attention.

The vital points to be considered are: (1) healthfulness of location; (2) convenience of situation with relation to the residence; and (3) care in design, with reference to convenience in feeding, egg gathering, etc.

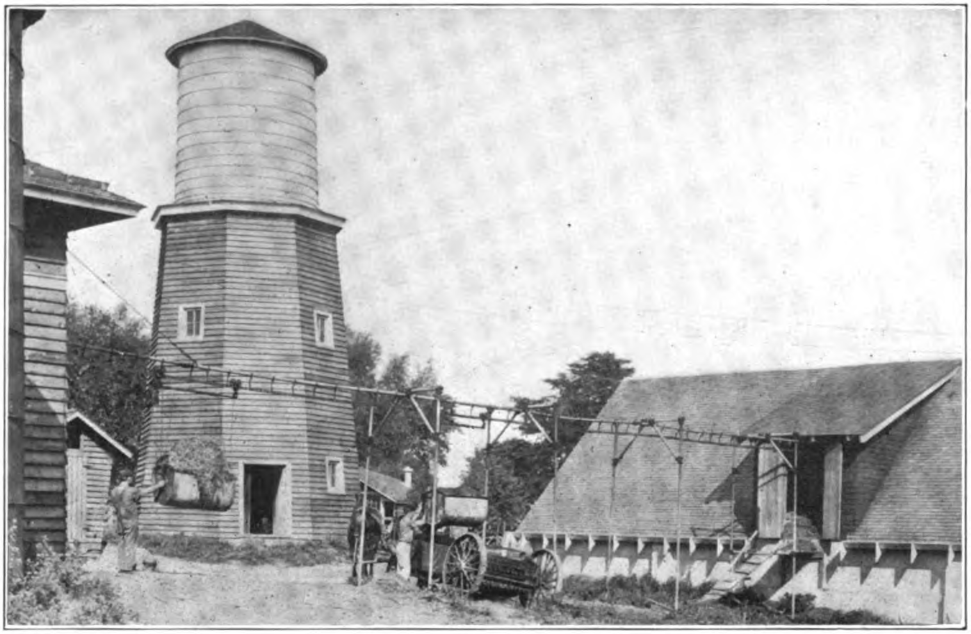
(1) The location of the poultry house should be a healthful one for the fowls, dry, and with good air and plenty of sunshine. Provide ample glass or canvas-covered open-

A complete layout of farm barns. *At left*, horse stables; *at right*, cow and hay barns (connected); *in the middle foreground*, manure pit and shed; *in the right foreground*, hog house

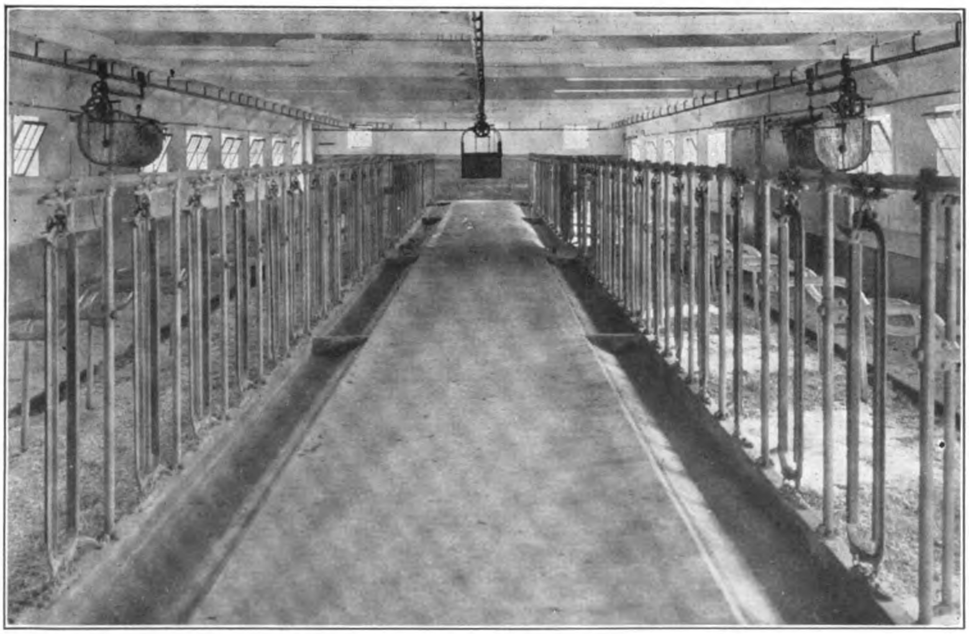


Range of horse, storage, dairy and cow barns on a Vermont farm, all facing south, close together and directly across the drive from the dwelling

FARM BUILDINGS MUST BE PLANNED AND PLACED WITH REFERENCE, FIRST, TO THEIR PURPOSE, AND, SECOND, TO THE NATURAL CONDITIONS OF THE LOCALITY



Rightly placed, between conveniently arranged buildings, a single track can carry both feed and litter conveyors



Concrete and metal are the safest materials for both stock and stockman, and the cleanest ana most sightly as well

**The Purpose of Modern Barn Equipment Is to Make Conditions Safe and Sanitary, and the Labor of the Daily Chores as Light as Possible**

ings on the south side, also fresh-air intakes and foul-air outlets operating independently of the doors and windows so that proper ventilation may be assured. If the ideal location is not high and dry enough, build the house high and fill in with gravel, cinders, or other porous material, to keep the place dry.

(2) The poultry house should be conveniently located with relation to the residence; and the walk between the two should be protected from rain, snow and mud. If a shelter roof is out of the question, a cement or plank walk should, at least, be provided, and this should be sufficiently elevated to drain and to keep off drifting snow.

(3) Careful design in detail with regard to convenience in feeding, cleaning, disinfecting, the division of flocks, egg gathering, etc., is important. A hallway, from which feeding and cleaning may be done without entering the room containing the flock, equipped with tilting or sliding feed troughs and automatic feeders, is simple to build, and can be so arranged, with feed bins overhead, that the feeding can be accomplished by pulling a lever that will open the spout from a hopper-bottomed bin to the feed trough.

## Buildings Under One Roof

The idea of grouping all buildings under one connected roof is a good one and has points in its favor, when the size of the farm will justify such arrangement, and when the farm is permanent and valuable enough to justify the construction of semifireproof buildings having effective fireproof walls between them.

Connected farm buildings should be built around an open court, which may be subdivided by walks or fences so that part may be used for livestock and part for a general yard with convenient gateways to the farm roads and the highway.

If the farm does not justify building the structures with masonry walls and fire-resisting roofs, the idea of connected buildings should not be considered. The walks between the several buildings may, however, be protected by shelters which could be quickly wrecked and cleared away in case of fire.

CHAPTER 29

# The Farmhouse: Its Location and Design

*By* Ruby Westlake Freudenberger, *of Columbia, Missouri, who was born and reared on a farm in Boone County, that state, but whose Maryland and Virginia ancestors make her in name and fact a Daughter of the American Revolution. After graduating, with two degrees, from the University of Missouri, she taught mathematics there for two years. From 1911 to 1917, she lived in Carson City, Nevada, where her husband was Chief Engineer of the Public Service Commission, and where she was named by the Governor as member of the State Commission for the Promotion of Uniform Legislation in the United States. She has, however, at all times, been deeply interested in the social and home problems of country life and the conditions that give rise to them, carrying on personal investigations, working out principles and methods, and contributing valuable articles on different phases of the subject to rural life publications. In connection with the technical engineering problems of home making, she has had the coöperation of Mr. Freudenberger (see Chapter 18) with a lifetime of training and practical experience behind him.*—Editor.

THE farmhouse is a distinct type of building. Its uses are as definite and characteristic as those of a shoe factory or a flour mill, and it should be planned and located with the same specific regard to the ends of its use as those buildings are. It should be highly specialized both in its plan and in its design.

The farmhouse is now being accorded the expert scientific thought which its importance has long warranted, and which promises, at least, to put it upon the same plane of efficient development with the purely utilitarian farm buildings.

## The Farmhouse is Both a Home and a Business House

While the farmhouse is a dwelling, some of the controlling considerations in other types of homes have no bearing here: it has its own peculiar set of conditions, and its problems must be faced and solved for its own peculiar needs. Suggestions and help may be gathered from a study of other dwellings; but in this the characteristic demands and distinctive quality of the farmhouse must not be forgotten. A study of houses reveals so many beautiful ones, pleasing because of perfect adaptation to surroundings and uses, that it is difficult not to be carried away by their charm and appeal, and to remember that they are not farmhouses and that they do not meet the fundamental requirements of the farmhouse.

The farmhouse is unique in that its purposes are twofold: it must serve both as a home and as a business house. As neither purpose must be subordinated to the other, the farmhouse must combine in its arrangement the essential demands of both.

The requirements of the farmhouse as a home differ very little from those of any other house, whether in city, town, or village, because the ultimate aims and broad purposes of real homes are the same everywhere. A house in which a home is to be established must provide for the physical comfort and health of the inmates, and for social activity commensurate with the standing and mode of life of the family; and it must also meet the need and desire for beauty in surroundings and aid in satisfying the aesthetic and intellectual demands of human existence, besides providing for pleasures and cultural pursuits. A good house is necessary to a good home, and a good home is necessary to proper human development.

**Wherein the farmhouse differs from other homes.** It is, therefore, not in essentials that the farmhouse should differ from other homes, but in a more rigid elimination of nonessentials. Life is simpler and less complex in the country than in the city; hence, the farmhouse should be simplified in arrangement and free from all useless ornamentation and complicated construction. Thus it will be easier to get about in and will require less labor to keep clean.

It is in the arrangements for lightening the housework, and easing up the strain on the housewife, that the problem of the farmhouse differs most from that of city houses; for the farmhouse is practically servantless. Every detail of the house should be designed, as far as possible, with a view to conserve the time and strength of the housewife, and to make it possible for her to provide clean, cheerful, and inviting home conditions for her family. Since she must be the homemaker as well as the housekeeper, she must be spared some vitality and spirit to devote to the care and training of her children, and to enable her to maintain a home standard in keeping with the demands of the culture and progress of the times.

In its industrial aspect, the farmhouse is not only the workshop of the housewife, but it is also the vital centre from which radiate all of the activities of the farm. It is a fundamental unit in the group whose aggregate is the farm plant. Its right placing and arrangement will mean much for the success of the farm as an industrial institution; for these will be factors in determining the whole plan of the farm operations, and the consequent labor program and efficiency.

## Problems Connected With the Choice of a Site

The great diversity of natural conditions of soil and climate in this country has given rise to varied systems of agricultural pursuits, each section developing and following that system best adapted to its needs and possibilities. These, in turn, bear strongly on the requirements, arrangement, and location of the farmhouse and on its position in the general layout of the farmstead.

Natural climatic conditions have a direct bearing, too, on the location of the farmstead; for it must be so placed as to furnish protection from cold and heat, snow and rain, dust, wind, insects, and unhealthful vapors.

The contour and the general surface conditions of the site must be such as to permit an economical and convenient arrangement of the group of buildings. Clearly, a bleak, rocky point or the side of a steep incline would not meet this demand.

**Selection of a site.** The time-worn adage "Circumstances alter cases" is nowhere truer than in choosing a site for the farmstead; there are so many factors to be taken into account, so many objectives to be sought, and so many conditions, natural and artificial, to be reckoned with. Some of these may be controlled or modified, while others, such as the natural properties of the site, are permanent and fixed, and

FIG. 465. The farmhouse is necessarily isolated from its neighbors; it should therefore be sheltered from storm and wind—a real haven of refuge and comfort.

must be accepted. These may be taken advantage of and so incorporated into the plan as to serve useful ends and add to the general charm and efficiency of the whole.

The dual purpose of the farmhouse complicates the problem of the site, as well as that of the plan of the house. The relative importance of the different elements involved varies in the different sections, and even for each individual farm. Hence, any plan must involve compromises and concessions, the giving up of some advantages to secure greater ones, or to allow the incorporation of features appealing to individual tastes.

The size of the farm; the system of farming followed; general climatic conditions; surface contours, bearing upon air and water drainage; the nearness and relation of the farm to the public highway; the source of the water supply; the outlook and general surroundings; and, finally, personal preferences—these are some of the more important points to be considered in selecting a site for the farmhouse. Probably no arrangement can be worked out which will secure the ideal adjustment of all of these details; but systematic study of their relations to one another and of their influence upon farm life will obviate many of the inconveniences and discomforts existing on farms to-day.

In the northern and northeastern sections of the United States, where the winters are long and severe, compactness of arrangement of the farm buildings is necessary. Here a site should be chosen that will provide some natural protection against snowdrifts and the sweep of winter winds, and will permit such a grouping of the buildings that the feed and the stock may be housed close at hand and be reached without the attendants having to go out of doors. The outbuildings, such as laundries, woodsheds, and storerooms, might advantageously form a series leading from the house to the barns.

FIG. 466. The farm home should belong to its surroundings; to this end stone obtained on the farm makes a highly satisfactory building material.

In the South, where opposite climatic conditions obtain, an open arrangement of the buildings allowing free passage of the winds is desirable, and the site should be so chosen as to take advantage of shade and the prevailing breezes to relieve from the heat of the long summers. Care must be taken to guard against odors from the barns being carried to the house, and special provision must be made to screen against flies, mosquitoes, and other insect pests.

On the wind-swept, treeless plains of the West, the problem, after the water supply has been provided for, is to find such protection as may be had from the dust and burning sun of summer, and from the snowdrifts, blinding storms, and freezing winds of winter. Angles and ells of the house may be so placed as to break the sweep of winds in winter and provide shady spots in summer. Outbuildings, also, will serve as shields, if located in proper relation to the house and yards.

In the Central West, notable alike for diversity of crops and diversity of climate, provision must be made against extremes of both heat and cold, against rainy seasons and periods of drought, against dust, mud, snow, hail, and wind. The site must be chosen with these demands in mind; and the great complexity

of the problem makes its satisfactory solution a correspondingly greater achievement. The short, intensive cropping season of the Corn Belt gives rise to a distinctive plan of operations; and this, in turn, calls for a particular and suitable farmstead arrangement.

In mountainous sections, sheltered sites, shielded against snowslides and exposed away from the usual direction of storms, are naturally chosen. The selection of the site is a matter deserving serious thought and most careful weighing of the many points to be considered. Our pioneer forefathers located their homes with a view to the sole requisite of nearness to a water source. They bothered not at all about drainage, malaria-laden fogs, open views, or step-saving plans. Consequently, we find many old homesteads in low places near springs, or on the hilltops just above them.

Once the site is chosen, it becomes about the most permanent thing on the place. It probably fixes the abiding place of generations of human beings, and the silent influence of its conditions and surroundings leaves its mark on the natures and constitutions of those who pass in procession there. Often, sentiment alone perpetuates it as a home, with all its satisfying or distressing qualities.

If the site offers such natural advantages as will make easy and economical the providing of modern conveniences and the many small adjuncts that mean so much for the comfort and well-being of the workers, the farm home may secure them; but, if a deal of labor and expense, and planning and changing be necessary to have them, the family most likely drifts along without them through years of accumulated discomfort and weariness of body and soul. If the sunshine and cool breezes and beautiful vistas, and gorgeous sunsets just naturally go with the site, the farm family have the benefit and inspiration of daily existence under such influences; but if they must be secured by some rearrangement of buildings or trees, or by some extra expenditure of thought and effort, they are most often done without. The far-reaching effect of site conditions makes the choice of a location for the farmhouse the prime consideration of the home builder.

**Desirable features of the farmhouse site.** The building site should be airy, sunny, and well-drained. These ends are best obtained by selecting a high, open space, where the sun and air can reach the house. This is as important for the lasting quality of the house as for the health of the family. There should be some large trees for both shade and beauty; but they should be so situated as not to shut out the breezes, and the shade should fall on the yard, rather than on the house itself. Direct sunshine on a house is more tolerable in summer than reflected heat from the ground, and is much to be desired in winter.

One seeming variation from this rule should be a tree to provide afternoon shade for a west porch or door. This tree need not be so near the house, however, as to violate the general rule laid down.

A densely wooded yard is dark, damp, and moldy, and is often as badly in need of ventilation as a shut-up house. Trees close up or touching a house hold the dampness, and cause the roof or walls to rot.

Fig. 467. Sunlight is as necessary in the home as in the barns. These trees are too thick and too close for either health or comfort.

Another important reason for choosing a high location is that this makes possible good drainage, and secures against damp yards, cellars, and foundations. So far as climatic conditions are concerned, the best location for a set of buildings is just over the

FIG. 468. A bare, unadorned building is never a real home. It should have a background, a setting as well as a pleasing outlook.

brow of a hill on the south slope. This allows more sunshine for the yards and buildings in winter—a great advantage in securing warmth and dryness. The high location will get the cool summer breezes, and the air will be purer as well as cooler. Damp, foggy, cold air settles in the valleys and low spots in still weather, and these places have fewer hours of sunshine. Destructive frosts, too, often form in low places, when the uplands escape entirely.

It may be objected that the high points are also more exposed to the sweep of winter winds; but if the slope be to the south or if there be a slightly higher rise to the north or northwest, this objection does not hold. Besides, artificial windbreaks may be provided by planting trees or by judicious placing of outbuildings.

There are many more artificial means of protection against cold than against heat, hence we must take advantage of all possible natural elements for keeping buildings cool in summer, and warm in winter. The summer is the time of stress for farmer folk, the period of greatest demands on their energy and endurance; therefore, the greatest care should be taken to provide them with every possible comfort and help for this season. In the winter, more of their time and energy is available for the promotion of personal ease and comfort.

A high location necessitates, of course, a climb every time the farmer or his helpers come to the house from the fields or from market; and if the barn is on the same elevation as the house, all the crops to be stored in it, as well as all building materials and general supplies, must be pulled up the grade. This is considered so serious a drawback by some farmers—it is not regarded so seriously by the farm wife, usually—that they allow it to outweigh all of the advantages of the high site.

However, on big farms—and it is only such that produce large crops to be stored or moved—extensive stock feeding is usually carried on. The feeding should be done over various fields for the economical distribution of the manure and for soil building, aside from other considerations. Extra storage barns might be erected on a spot having the general level of the fields or road, so that a comparatively small amount of hauling need be done to the hill barn.

The high location commands a view of the surrounding country and makes use of the subtle influences of beautiful scenery and picturesque surroundings. Often the outlook alone would justify the choice of the most elevated spot. The road up to it may be rough and steep, but no height is ever attained without its climb. The aesthetic phase of the building site does not often receive the attention it deserves. Splendid views and inspiring landscapes are permanent features of the estate; their influence is a constant force; and they are ever-present sources of pleasure and aids to uplift.

The homestead on an eminence gathers something of impressiveness and dignity from its elevation and commanding position.

**House should be well back from highway.** The farmhouse should be well back from the main highway, alike for artistic reasons, in order to be out of the dust zone, and to secure comfortable privacy and seclusion.

Just how far from the road it will be necessary to place the house, to escape the dust, will depend upon the direction of the house from the road; for the direction of the prevailing winds determine the width of the dust area. For instance, a house north of the road needs to be farther back than one on the south side, as in most sections of this country the prevailing winds are from the south.

especially in summer—the dusty season. It has been estimated that, in order to be safely away from the dust, a house north of a well-traveled highway should be set back 40 rods; south of a well-traveled highway, 4 rods; east of the highway, 15 rods; and west of the highway, 20 rods. These distances, however, except possibly the first, are hardly great enough to meet the demands of the best landscape effects.

The advent of the automobile and its extensive use as a means of country travel have widened the dust zones and, at the same time, have removed some of the social reasons for placing the house near the road. The automobile, rural delivery, and the telephone have done away with the need of having the home so placed as to enable the farmer's wife to look up from her work and view the passing along the road as a social diversion and as a means of keeping informed regarding the movements of the neighbors.

**Ample grounds and a private driveway desirable.** No farmhouse, however beautifully designed, can give its best effect or show to its full advantage unless surrounded by ample grounds and given a setting and background consistent with its style and feeling. A farmstead cramped for yard space, and pushed up so close to the highway that it seems to be straining the division barrier, is fatally lacking in beauty, comfort, and sanitation. Nearness to the street or road may be advisable or necessary in towns; but it is out of place in the country, and out of keeping with the character and spirit of country life. The essential quality of the country is openness and spacious repose.

A most attractive arrangement is to have a private road from the highway leading to the house through a wooded pasture. Such a pasture, with the road winding its way among the trees and up the slope to the house beyond, enables the place to present to the world a stately and prosperous front, and assures a pleasing first impression upon visitors and passers-by. This approach to the house should be so provided that there will be no gates to be opened and closed until the one main entrance to the house is passed and the barnyard enclosure reached. "The one main entrance to the house" is here emphasized, because there should be but one public entrance, and the approach to it should be the driveway. There should not be a front entrance and a side entrance, because in the farmhouse the front entrance will not be used. Nothing superfluous belongs with the farmhouse, not even a front door. The house should be so planned as to throw the main entrance in the logical relation to the service rooms demanded by the conditions of farm life.

FIG. 469. The New England colonial type of country house; severe, simple, well-proportioned and roomy

## Location of the House with Relation to the Outbuildings

The house should be near enough to the highway to be plainly visible from it, and there should be open spaces in the woods allowing a clear view of the house from the road and of the road from the house.

Locating the house with reference to the source of the water supply is not so important now as formerly, except in the arid or semiarid regions. Deep wells, windmills, gasoline engines and modern mechanical systems for storing and distribution, make it possible to supply adequate water for almost any site. Bored wells are sometimes a too expensive source of water supply, especially in sections where it is necessary to go very deep; but, failing other sources, it is possible, with proper care and attention, to have anywhere in the area of rainfall clean, pure cistern water.

A rise of ground slightly higher than the house site will supply a spot for the storage of water and permit the use of the economical gravity system of distribution. This rise will serve, also, as a windbreak, if in the right direction from the house. If, however, this elevation is so great as to shut in the house site, and cut off a good view, it will be more of a drawback than a benefit.

The building site should not be too near a boundary line of the farm; else, conditions beyond control are brought almost to the doorstep, and corn fields or stockpens may appear in unpleasant proximity. Even an intervening road does not always remove this restriction.

**Position of farmstead with relation to the fields.** On a small farm, the position of the farmstead with relation to the fields is not especially important, but on a large farm, this item moves far up in the scale. The many trips to the fields in the production and harvesting of the crops, and the inconvenient handling of stock, on a poorly planned farm often aggregate in the course of a year miles

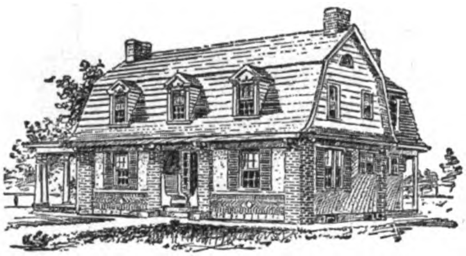


FIG. 470. The Dutch colonial type is common in Pennsylvania and a few other localities, but it is hardly a typical farm style.

of unnecessary steps and days of wasted time. From the sole consideration of the desirability of being within the easiest reach of all the fields, the farmhouse should be located near the centre of the farm. This is not advisable, however, unless the public highway pass through the farm; for such a location would probably result in a demoralizing isolation, instead of in the comfortable privacy which should characterize the country home. The farmhouse being off the line of general travel, visitors would be few, and strangers rarely seen.

If the relation of the farm to the public road be such that the farmstead may be placed near the middle of one side, this will be a most satisfactory arrangement, especially if the farm be oblong and a longer side takes the home site. It is better to have the house in a corner of the farm, even though this be a long way from the farthest field, than to have it too far from the public road. This road is the channel of communication with society and the outside world, and this way lie church, school, neighbors, and market. Many more interests call from this direction than toward the fields, and the aggregate of trips out this way far exceeds those in any other direction.

**Orchard and garden.** The orchard and garden should be within easy reach of the house, and their location should be part of the original planning of the farmstead. The presence of suitable soil and exposure for these should be taken into account in the choice of the site. Further, an orchard behind or at the side of the house supplies an artistic landscape feature so effective and pleasing that it will cover a multitude of small blemishes; also, it provides the ideal poultry range.

The house should be so situated with relation to the barns as to be out of reach of odors. As a fire precaution and for protection from odors and flies, it should be on the windward side of the barn, and at least 250 feet away from it. To have the house and barn near each other saves time and steps for the farmer, and adds to convenience in the care of stock; and this is advisable so far as the demands of sanitation and safety from fire permit.

The prevailing summer breezes are from the south and southwest; and it seems the wiser to relate the buildings with regard to summer conditions rather than to those of winter, because the house is open more to the breezes and, hence, is affected more by outside conditions at this time. From this consideration, the barn should be placed north or northeast of the house. It is true that the yards are drier and cleaner in the summer, and there are fewer troublesome odors than in the winter, so that a position south of the house is not so objectionable, if other considerations make it desirable. The *distance* from the house, more than the direction, will control the odor and fly menaces.

**Barnyards and outbuildings.** A more important point for consideration here is that the outlook from the house shall not be over the barnyards. As most houses are planned with the living rooms on the south and east, the location of the barns north or west of the house would be best for this particular object. However, modifying conditions may be brought in, whatever the relation of house and barn. The barnyards may be put north of the barns, if it is desired to put the barn north of the house; and the north fences of the yards may be so constructed as to serve as shields from cold winds, though this is not the most desirable arrangement for the comfort of the stock. Proper planting of judiciously selected shrubbery will effectively screen the barn from the house and still not interfere with the enjoyment of the distant view in that direction. A combination of a water tower and garage may also accomplish this end.

The dwelling should dominate the group of farm buildings. It should stand in the foreground, with the outbuildings grouped back of it in such a way as to give it support and prominence, at the same time conveying the impression of the proper relation of each building to the others and emphasizing the general unity. The outbuildings should be grouped, not scattered about promiscuously giving in the latter case the impression of a little town without order or system in its layout. The offense, to the sensitive eye, given by numerous buildings dotted in disorder around a house, is similar to that produced by shrubs and flower beds peppered over a lawn. No building except the house should stand out with distinct emphasis from the group effect. The same materials should be used, and the same general architectural design and system of roof lines should be followed in all the buildings, to secure the best artistic results.

The outbuildings should be grouped away from the windward side of the house, to reduce the fire hazard, if this can be accomplished without sacrificing too many other

important requirements. All of these buildings, except the barns and poultry houses, should be near the dwelling; in fact, they should be incorporated in its general plan, and should connect with it by sheltered and paved or floored passages. The housewife should be able to reach all of her supplies and carry on all of her domestic activities without the need of exposure to the weather in either summer or winter. To make this possible, the laundry, the smokehouse, the fuel storage room, the general storeroom, and the well should be connected with the house.

This arrangement, of course, increases the fire hazard somewhat, though not greatly, as the barn is not in the group, and the passages leading to the outbuildings may be of flimsy construction, quickly removable in case of fire.

**Have trees about the house.** No country building site should be devoid of trees. If possible, a site for the farmhouse should be chosen having some large native trees; but, if this cannot be done, a few of a quick-growing variety should be planted and carefully guarded. Comfortable, shady spots in the yard will invite to the outdoor performance of many tasks usually done inside, and every means of encouraging outdoor living should be utilized.

A tree so placed as to shield the dining porch from the direct rays of the morning sun will add to the comfort of the breakfast hour. Also a tree to the west of the house, to protect a porch or door from the glaring afternoon sun, is an invaluable adjunct. The general location of trees should be away from the house, and there should be abundant openings between them, to allow full benefit of the distant views. A spreading, stately tree in intimate sheltering relation to the house provides an adequate and pleasing decorative feature, enhancing the architecture, and adding to the home character of the group. Heavily wooded areas serve well as landscape features and as wind and storm screens; but they should be in distant relation to the house, else they will shut it in too much. They also harbor animals which prey upon the poultry and young stock of the farm and are obnoxious in many ways. Trees about the house should not be allowed to cut off a fine view nor make a break in a charming vista. They should serve merely as frames for the pictures of the landscape.

FIG. 471. Either dressed or field stone set in mortar combines well with wood trim and gives a warm, attractive, durable structure.

## Design of the House and Site Intimately Related

There is such an intimate relation between the design of the farmhouse and the site upon which it is to be placed that each should be selected with the other in mind. If one's choice is fixed upon a particular type of house, he must look about for a suitable site; if the site is already selected, then it is the task of the designer to evolve a building in harmony with the location.

The latter is much the more usual process and the wiser one, for the design of the building is not nearly so important as a successful house. To be successful, it must be comfortable, convenient, and satisfying to the eye; it must meet the demands of the particular purpose of its construction; and it must fill its part of the requirement for a beautiful whole.

No ugly house is a success. Beauty is not expensive; it does not add to the cost of houses. It is a by-product of simplicity and efficiency in design and construction. It is often given away and ugliness bought. Beauty does not mean ornateness or pretension, nor is it a matter of elaboration. On the contrary, it is obtained for the farmhouse by simplicity of line and composition, structural honesty, harmony with its surroundings, and adaptability to its specific uses. "The line of beauty is the line of perfect efficiency."

The farmhouse is an all-year home, and it must be designed with definite regard to climatic conditions. Large porches, open passageways, and many provisions for outdoor living should go with houses for warm, mild climates. More compact designs, emphasizing arrangements for conserving warmth, such as put-


FIG. 472. A farmhouse designed for southern conditions. The abundant windows, overhanging eaves and interior ventilating system afford valued protection against severe summer heat.

ting chimneys and fireplaces on interior walls, vestibuled entrances, and fewer porches, are suitable for cold, windy locations.

The design of the farmhouse must be made with a view to economical and simple construction. The cost must be kept low; and this may be best accomplished by eliminating useless decoration and such features as towers and swell ends, and jig-saw work for the cornices, porches, and railings. Often the building is done by the country carpenter, assisted by the farmer and unskilled farm labor. Fancy features, involving complicated carpentering, must be omitted for this reason as well as for economy and good looks. The house should be so designed as to have no angles and corners and cubbyholes wasting space and material and labor. Restricting the plan mostly to square spaces and rectangular effects will make this much easier.

**Features which the design should include.** The design of the farmhouse should include features especially favorable to outdoor living. It should be characterized by generously proportioned porches, suitable for use as a dining room or a living room, or the two combined. Sleeping porches also, will add much to the health and comfort of the family. The two-story porch of southern houses is a most pleasing feature for mild climates, as it provides delightful outdoor sitting rooms and bedrooms. Also, an open passageway leading to the "summer kitchen," when screened against flies, makes a pleasant summer dining room or living porch.

The farmhouse design should keep to simple roof areas, as the more valleys and hips there are, the more leaks there are liable to be. The steeper the roof slope, the better the drainage and, consequently, the more lasting the roof. Roof areas exposed to the north last longer than those to the south, hence for durability irregular roofs should have their long slopes and greater areas to the north.

A house should be typical of the life of the people who live in it; hence, the farmhouse should be unpretentious, and devoid of "fussy" features. The farmhouse is not the house of the country place, nor the suburban home of the city worker, nor the summer cottage for vacation time only; and it cannot be properly designed or planned in keeping with the requirements of any of these, though all are houses in the country.

In size and general outline, the farmhouse should be impressive enough to harmonize with the importance of the estate. It should be large enough to provide everyday comforts for all the members of the family, and should include reserve accommodations for times of extra demand. It should include a spare room, because the traditional hospitality of the farm home should not be lost, and the comfort of the family should not need to be disturbed every time there is an overnight visitor. The house should not be made large simply to look imposing, and it should not include rooms and features not demanded in an ordinary year's exigencies. Too large a house puts the investment out of proportion to the farm value, and ties up capital in useless buildings; but, on the other hand, there should be no suggestion of niggardliness about the farm home. Generous provisions for comfort, but nothing superfluous or wasteful, should mark the farmhouse plan.

**Proportional cost of farmhouse.** The proper proportion between the amount to be put into the farmhouse and the total farm investment, or the relation of the

cost of the house to the farm income, is a very difficult problem. It involves the personal feelings and tastes of each farmer regarding the quality and appearance of his home establishment. Moreover, the actual monetary return from the investment in a good house and domestic conveniences, while a very real thing, will not be as high as the return from capital put into other equipment. This is because the benefits and influences of a home cannot be measured in dollars and cents. Where surveys have been made, it has been found, in a majority of cases, that the house represents the net farm income for 1 year.

Whatever the design chosen, the farmhouse should be simple and dignified. It should be set in neat, well-kept surroundings and guarded from neglect and misuse.

The design should not be too severe and inflexible; else, it will be out of keeping with the character of the country. The farmhouse should have stateliness without austerity, dignity without rigidity. It may well be of the rambling style, to secure light and air for all the rooms, as space is plentiful and the outlook open in all directions. Indeed, the unrivaled advantage in locating and designing the farmhouse is ampleness of space and unblocked outlook.

## General Principles Governing the Selection of the Style of House

Some broad principles may be laid down governing the style of houses suitable for certain sites; but this is a bit dangerous, because some striking peculiarity of a site may so dominate it as to reverse the usual laws, and any attempt to apply general rules without a thorough comprehension of modifying conditions may bring quite the opposite result from that intended.

**Farmhouses should be two-storied.** In general, however, farmhouses should be 2-storied, or should have tall, steep gables, or long, sloping roofs or, in some way, present long, vertical lines. Such lines blend with the effects of trees and hills. A low, flat house in a rolling, hilly country appears dwarfed and squatty by contrast with the dimensions of the hills and the massive, towering effect of tall trees. Clearly, a simple, flat bungalow is not suited to crown a stately hilltop.

On the plains, the same law of emphasizing the natural lines of the landscape holds; so that here architectural features should be handled so as to produce horizontal lines. That is, roof areas should be long horizontally and not be broken by dormers; windows may be grouped; and even the manner of using the wall material, whether wood or masonry, may contribute to the horizontal effect. A house may very well be 2-storied without conflicting with this requirement, and the rambling house may very easily be handled so as not to violate the need for vertical effects in the broken country.

It must not be assumed, of course, that in the effort to bring out a general artistic effect, *all* of the outstanding lines of a group should be vertical or horizontal; for, quite to the contrary, there should always be a minor note of vertical lines to balance a mass of horizontal ones, or just the reverse. The flowing, sweeping lines of plain and prairie need the balance produced by the perpendiculars

FIG. 473. The Spanish Mission type of architecture is well suited to, and has been largely adapted for, farm conditions in the arid sections

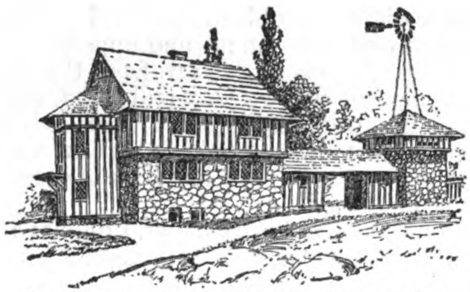


FIG. 474. The so-called half-timber construction on a basis of stone or cement is of English origin but is being widely used in this country.

of trees, towers, or windmills. The base lines of hills, in general parallel with the sky and horizon lines, give the needed balance to the up-and-down effect.

The horizon line of the landscape should serve as a guide to the sky line of the house, so that the general roof lines and contours simulate those of the surroundings. It is best, however, to attempt only the simple and obvious in roof lines unless the services of a competent architect are employed. The roof presents the most delicate problem for the artistic power of the architect, and its successful handling requires the exercise of his rarest skill and ingenuity. It is literally and figuratively the crowning achievement of the complete artistic whole.

## Architectural Styles

**The Colonial.** There have been developed in the different sections of the country characteristic designs of dwellings, each having qualities of especial appropriateness to its native section. Each in some subtle way is an expression of the civilization and home spirit of its community.

The austere, inflexible New England Colonial style is a very difficult one to adapt to the needs of varying farm conditions throughout the country. The more graceful and gracious Southern Colonial, with its curving porticoes and stately columns, while a shade more adaptable than the New England Colonial, is impractical because of size and arrangement for any but a very few farm homes. The Spanish Mission style of southern California is distinctly local, though very charming where the climate and landscape make it suitable.

The Dutch Colonial style is a very successful modification of the New England Colonial. It is a cottage type of architecture for a 2-story house. The cottage effect is obtained by extending the roof down to the usual height for a 1-story building. The height necessary for the second-story rooms is obtained by using the gambrel, or double-pitch, roof, or by employing long dormers breaking through a single pitch from ridge to plate. The detached dormers only should be used with the gambrel roof.

This is a very beautiful domestic style, and, as it is more flexible in plan and design than the other types of Colonial, it is adaptable to a wider range of local conditions. The balancing of vertical and horizontal lines harmonizes this type with many varying landscapes.

Both the gambrel and the single-pitch types of Dutch Colonial are most excellent ones for farm use. Their roof systems are easily adaptable to all outbuildings; and both types have a brooding, homey air, coupled with the impression of complacent self-sufficiency, typifying some of the finest qualities of country life.

**The half-timber style.** The half-timber house is among the best styles of architecture for farm use. Perhaps no style better meets the demands for flexibility in farmhouses than this one. Half-timber work to-day only simulates the original method of construction given this name. In England, where the style originated many generations ago, the walls were constructed with timbers—some upright for supports, and some inclined for braces—and the spaces between these were filled with masonry. As now built, half-timber work consists, in part, of stucco walls paneled with boards. In a sense, this is a sham; but the varying line effects, which may be produced by skilful handling of the timbering, blend with so many varying landscape conditions that the style has a value by which it persists in spite of this drawback. When only vertical paneling is introduced, the type should not be used on treeless plains.

This style is wholly free from the restrictions as to symmetry and spacing which control the construction of the Colonial types. In these, the floor plans are made to conform to the windows and the gables and the entrance. The front door is exactly centred; all of the windows are of exactly the same size, and are exactly spaced with relation to the door and one another. In the half-timber house, the floor plan can be developed with sole regard to convenience and comfort; the chimneys can be placed where most needed; the windows can be high or low, large or small, grouped or scat-

tered. Its well-braced stucco walls offer more than ordinary resistance to heat and cold, winds, and fire, and make it suitable for a wide range of climatic conditions. It is comparatively inexpensive, as the first cost is reasonable; and the upkeep cost is small, since weather conditions have but little effect upon its surface.

FIG. 475. The bungalow is not the cheapest type of house to build; but it is easily cared for, and fits in admirably with the needs and conditions on many farms.

**The bungalow.** The bungalow is a widely used architectural style for farmhouses. It is a southern type especially suited, in this country, to the Southwest, where it has been developed and is very popular. It has long since broken over the boundary of the Pacific West and Southwest and is now the most popular of small houses in practically all of the states, regardless of climate or topography.

This wide popularity and ready acceptance are unmistakably due to innate merits. Chief among these is flexibility in plan, construction, and design, and its consequent adaptability to a wide range of conditions. It is essentially a country type of house. It is out of place in cramped, shut-in quarters. It belongs where it can open to the view and the breezes on all sides. It can be built of wood, brick, stone, or stucco or combinations of these; it can be constructed so as to provide the most rigid protection against severe winter conditions, or be made in keeping with the needs of milder climates; it can be of one story or 2-storied. It can undergo almost endless modifications without giving up its distinctive character or losing some of its most desirable features, such as the low sloping roof, the extended cornice, and the wide veranda. It offers better opportunity for individuality than the more pronounced styles of architecture. Its broad adaptability to many kinds of building sites eases the problem of the general artistic result. It can be made an inexpensive style, too, especially if designed with an upper story, which will lessen the cost of foundation and roof. The compactness of the floor plans, the omission of many partition walls, the plainness of finish, and the absence of ornamentation reduce to the minimum the cost for the interior. Its built-in fittings secure many conveniences within a small space; and these fittings cost less than a corresponding amount of furniture. The completed bungalow is almost furnished.

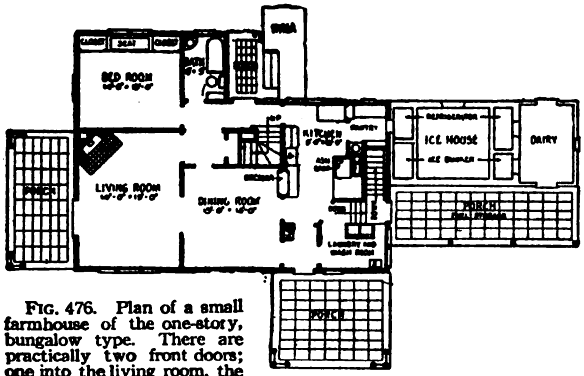


FIG. 476. Plan of a small farmhouse of the one-story, bungalow type. There are practically two front doors; one into the living room, the other into the hall, kitchen and wash room. Note the dairy and cold-storage house reached via the covered porch.

# CHAPTER 30

# The Farmhouse: Its Construction and Arrangement

*By* RUBY WESTLAKE FREUDENBERGER *(see Chapter 29). The construction and design of any house—and especially a farmhouse—are inseparably tied up with its location and arrangement and the materials of which it is made. Each of these details has a very important bearing upon the efficiency, as well as the comfort and happiness, of those who live in it. Fortunately, therefore, it was possible to have both aspects of this subject treated by one authority—an authority, moreover, who not only knows its principles, as a result of study and observation, but who also is familiar with their application, as a result of practical farm life and the varied experiences such life affords.* —EDITOR.

THE chief aim in the construction of the farmhouse should be the production of a substantial, solid, weatherproof building. In every part, emphasis should be laid upon utilitarian features; and the money invested should go for the genuine essentials of stable construction, and not for showy, shoddy elements or attempted ornamentation. The farmhouse stands more alone in its buffetings by the elements than does the town house. Usually it has no near buildings or adjoining walls to shield it and help bear the strain of its weight. It is open on all sides to the straining, twisting force of the wind. It must provide its own resistance to cold and heat, dust and rain, sun and hail. Also, the danger from fire is greater in the country, because of the lack of fire-fighting facilities. Construction features designed to withstand these peculiar exposures should be introduced.

## Construction Items Requiring Special Emphasis

Because economy is so important in building the farmhouse, only material and workmanship of good grade should be employed. The farmer can ill afford to pay the labor cost for flimsy construction and the putting in of poor material, soon to be repaired or replaced. A high first cost is cheaper in the end than repetitions of smaller outlays.

Emphasis should be laid upon such features as deep, solid foundations, double floors properly laid, fire stops, well-built chimneys, deep cornices, good plumbing, and ample guttering. All of these have a direct bearing upon the comfort and health of the family as well as upon the durability of the house.

FIG. 477. The money saved by using piers instead of a foundation will be spent in keeping the house warm. The best plan of all is to include a real cellar.

Foundation walls and not piers should be used. The house perched upon piers is unsightly and unstable-looking as well as uncomfortable. The extra fuel and labor needed to warm and keep clean such a house would soon overbalance the saving by the omitted underpinning. Cold floors and cold feet are inevitable with such construction; for the cold winds sweep unchecked under the house, and, in cheaply built houses, a thin board floor, often with cracks in it, is the only structural protection provided. Necessary measures should also be taken to guard the foundation and basement wall from ground water and dampness.

Double floors afford protection against cold and heat, dust and wind. The subfloor should not be broken by partition walls, and it should be laid diagonally, so as to break joints with the top floor. The joists under the floor should be nailed together, where they lap, so as to make continuous ties across the building. A floor so constructed serves as an efficient wind brace for the building as well as a fire stop between the stories.

**Fire precautions.** It is especially important that some method be used to fire-stop every enclosed space in the framework of the farmhouse. Help for fire fighting is usually a long way off in the country, and every means of checking a fire in its early stages should be provided. Confining it within the space of its origin for even a few minutes, until help arrives, may mean the saving of the building. Fireproof guards should be placed about stoves, ranges, furnaces, and other containers of fire. Chimneys should be built from the ground up, not put on wooden shelves. They should be straight, not pulled over to extend through the peak of the roof. It is desirable, for the sake of the better draft, to have the chimneys built to the highest point of the roof; but this should not be secured at the risk involved in the inclined chimney.

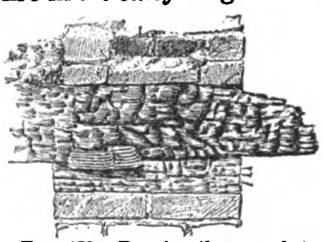


FIG. 478. Drawing (from a photograph) of poor, unsafe floor and chimney construction that is nothing less than criminal carelessness.

A low, wide cornice shades the windows and walls of the upper story, protects the side walls from rain and the wear of the elements, and carries the roof water away from the ground near the house. Ample guttering, properly put on and screened, in connection with the wide cornice takes care of the drainage from the roof and provides a supply of clean, fresh water for household use.

**Good plumbing a necessity.** Too much emphasis cannot be laid upon the necessity for good plumbing. The housewife who stands for hours at a time inhaling the poisonous gases from an untrapped drainpipe and sewer is more exposed to disease than if she had no kitchen sink and no system of plumbing. Safe plumbing for bathtubs and water-closets cannot be done inexpensively by present methods; and, in the effort to keep down the cost, farmhouse plumbing is often intrusted to unskilled workmen, with most disappointing results. A thorough understanding of the requirements of a sanitary equipment and a rigid adherence to these demands, are necessary for the installing of a safe plumbing system. Cheap plumbing is an expensive economy and not worth the risk.

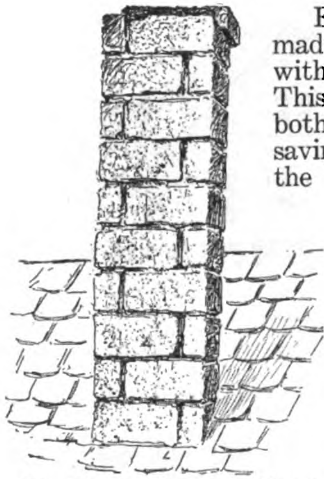


FIG. 479. Unsafe roof and chimney construction is worse than interior carelessness simply because its consequences are harder to fight. Keep rafters away from the bricks and everything in good repair.

Exposed floors, ceilings, walls, and roof should be made so as to prevent transmission of heat both from within during winter and from without during summer. This is not necessarily expensive, and is desirable for both winter and summer. It is very probable that the saving in fuel would soon pay for the cost of insulating the walls of north, northeast, and northwest rooms, which, without such protection, would require from 10 to 20 per cent more heat than south rooms. Windows may be made extra tight by double-glazing. The amounts of heat that are transmitted through windows that are single and those that are double-glazed have been computed and found to be as 10 is to 6. At least, the north and west windows of much-used rooms might be economically double-glazed.

**Good ventilation must be provided.** Farmhouses are notorious for being poorly ventilated. Paradoxical as it may seem, it is regrettably true that fewer farm dwellings have a constant supply of fresh air in them than any other class of homes. Where there are open fires, and the walls, windows, and doors are especially favorable for air leakage, a reasonable supply of fresh air gains entrance in spite of utter disregard of provisions for ventilation. Some system for bringing in fresh air from the outside and allowing the escape of the foul air from the inside should be provided as an adjunct to the heating system of the house. The great number of cases of tuberculosis in farm families attests the fact that the outdoor occupations of country life do not obviate the need of good ventilation in the house.

Attic ventilation will make the house cooler. The circulation of air between the roof and the ceiling carries away some of the heat. Ventilators in the roof and in the soffit of the cornice should be provided for this. Also, there should be openings in the foundation to secure free circulation of air under the house, to prevent damp, moldy floors, and decay of the floor joists. Dampness, darkness, and stagnant air provide the most favorable conditions for dry-rot.

## Choice of Material

The choice of material for the building of the farmhouse will be largely affected by local conditions. In building it is always best—from considerations of both beauty and economy—to use native materials.

**Wood.** Wood is by far the most generally used material for farmhouses. It is more widely distributed naturally than any other material; it is easier and cheaper to transport; it is more pliable and adaptable to various forms and uses; and, consequently, it is more easily handled, and its successful use does not require so much skill and training as other materials on the part of workmen. Wood lends itself to certain artistic effects which are difficult to obtain with other material, and the designing of a wooden building suitable for a dwelling is not quite so delicate a task as that of adapting masonry materials to this end. All of these things combine to make the wooden house the cheapest, for the same grade of workmanship, finish, and structural excellence.

On the other hand, wooden houses are less durable than those of brick or stone or concrete. Still the wooden house is not necessarily short-lived. Many may be found in this country to-day which have been standing for more than a century, and some for more than double that time. With proper-sized framing timbers, put together with due

regard to strains and stresses, wooden houses of great strength and endurance may be constructed. Indeed, a well-constructed timber house will be more lasting and satisfactory than a poorly constructed one of masonry.

Because wood is the simplest of all building materials to handle and adjust to the needs of construction, skillful and careful woodworkers are more plentiful and less expensive than good masons. For cheap and medium-priced houses, wood is to be recommended.

The most serious objection to wood as a building material is danger of destruction by fire. In spite of every precaution and safeguard, this is always a menace. While it may be reduced, it cannot be removed—at least, not until fireproofing processes have become further perfected.

The necessity for painting, or in some way weatherproofing, is another disadvantage of wooden buildings. This is an expensive item and one that needs attention every few years. In some climates, wooden buildings so soon become shabby and worn in appearance, and require such constant attention to keep them looking well, that it is hardly desirable to use them.

The cost of a wooden house is subject to greater variation than that of one of any other material, because of the possibilities for greater variation in the quality of its construction. It may be either a flimsy, inferior affair or a very valuable, high-grade structure. There is a smaller range of quality in masonry than in wood construction.

Where local materials can be used to a large extent, and the rough, heavy work, such as hauling and excavating, can be done with farm labor at farm-labor prices, the cost may be much reduced. Framing lumber from country sawmills will cost only about half as much as the ordinary town lumber markets demand. It is possible, where the farmer superintends and manages the entire job himself, to build a frame house at a cost of about $300 a room, or from 8 to 10 cents a cubic foot of inclosed space. This gives a well-built, plain house with medium-sized rooms, having all of the accessories needed for comfortable living, but devoid of unusual or fancy features. It includes shingle roof, good cornice, sash weights, and window blinds. A slate or metal roof will add one-fourth of a cent per cubic foot to the cost.

**Brick.** Brick comes next to wood as a widely used material for country houses. At least, this was formerly the case; but stucco is now rapidly moving up in popularity. Brick is more costly than wood or stucco. It makes a durable, substantial building, warm in winter and cool in summer. In proper construction, it will meet most satisfactorily all of the requirements for a superior home. If well designed, it is suitable for almost any style of house, whether bungalow, Colonial or in combination with half-timber or stucco. A brick dwelling has an air of permanence and substantiality, putting it in especial harmony with country homestead conditions. It has greater distinction than a wooden house designed and built with the same care and skill. It is also suited to a wide range of climatic and landscape conditions. It is especially beautiful in sections where there is much foliage and many rolling grassy slopes, the constrast of brick with the richness of evergreens in the landscape being most pleasing.

The upkeep cost of a brick house is small. Such a house does not require painting and it is not easily susceptible to the wear of the elements. It does not require either weatherproofing or fireproofing. If given a slate or tile roof, it is practically fireproof from the outside.

In common with all ordinary masonry dwellings, the walls of the brick house should have a damp-proof course, above the ground line and below the floor joists, to intercept the rise of ground water, which, without this impervious layer, will rise to a height of several feet above the ground. There should also be one or more air spaces in the walls, to prevent the water absorbed by the masonry from penetrating to the walls and plastering. It is better if this space be near the outside of the wall, behind a veneer of masonry, as this will prevent the rain water from penetrating the greater depth of the wall.

The costliness of the brick house is the greatest obstacle to the use of brick as a building material for the farmhouse. The labor cost for construction is greater than for wood; and, if the brick must be transported, even a short distance, the freight charges soon amount to more than the cost of the brick. If local brick is available, however, this objection is overcome. Brick farm dwellings will cost from 2 to 3 cents more per cubic foot than wooden ones. The brick-

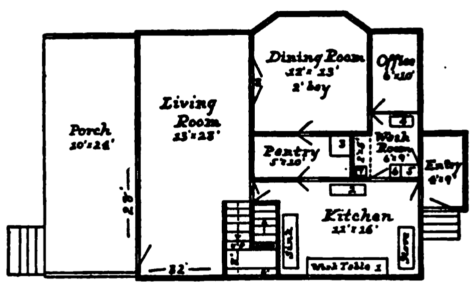



FIG. 480. First-floor plan of a set awarded first prize in a practical farmhouse contest conducted by the Iowa Agricultural College. 1, Built-in table cupboards and bins below; 2, wheel table; 3, iceless refrigerator; 4, wash basin; 5, chimney; 6, clothes chute, second floor to cellar; 7, toilet, screened. For second floor and cellar plans see figs. 481 and 486

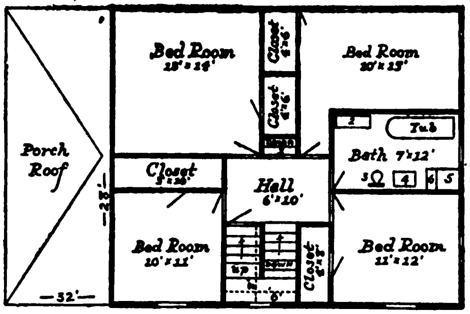



FIG. 481. Second-floor plan of farmhouse shown in Fig. 480. A sleeping porch could easily be built outside the bedrooms. 2 is a linen closet. The chute (6) saves carrying soiled clothes to the cellar.

coated house has many of the merits of the all-brick one, and costs slightly less. However, the fire hazard is increased somewhat in this type of house.

**Stucco.** Stucco is a most satisfactory building material for dwelling houses and is fast becoming very popular. It is well suited to the farmhouse, because its cost is moderate; it is as nearly fireproof as brick or stone; it is warm in winter and cool in summer; and it is adaptable for use in all farm buildings, making a pleasing, harmonious farm group.

A stucco house is but little more expensive than a wooden one, especially if constructed with the outside plastering on metal lath attached directly to the studding, thus omitting the wooden and paper sheathing used in frame houses. In this method, before the interior lath is put on, the outside wall is back-plastered, which makes it about an inch and a half thick and completely incloses the metal lath. This gives a very rigid construction, and effectively braces the framework of the house. A more expensive construction is to put the usual sheathing on the studding and to use the stucco covering merely in place of the weatherboarding. Many authorities consider this an unnecessary expense, as the stucco wall is entirely efficient without it, and there is no practical reason for its use.

In some sections, the stucco house will cost no more than the wooden one. Where the metal lath is used for both inside and outside plastering, giving a permanent construction, it is found that the increased cost over the wooden house is only about 3 per cent. This addition would be more than consumed in an extra coat of paint for the wooden house. Sand and gravel for the concrete and stucco-work may often be obtained near at hand, and at no cost except for hauling. If the materials used in the stucco house are up to standard specifications, and the work is of good grade, the upkeep cost of the house is very small.

Stucco is a most responsive material and is readily adaptable to any architectural design. It is suitable for large houses or for small ones, for very simple ones or for those of a more massive, and pretentious character. It combines well with other building materials; it is susceptible of many different finishes, and it can be varied as to color and texture so as to obtain any desired result.

Stucco houses are suited to a wide range of landscape conditions. The possibilities for many color combinations in their development fit them for particularly beautiful results among the hazy pinks, purples, and grays of the western mountains and plains. Fittingly designed and properly constructed, they are attractive in any surroundings, and they have a dignity and reserve found in few other houses. They age gracefully, taking on with time a mellowness of tone which adds to their charm.

Stucco over hollow tile makes a satisfactory and durable construction, but is somewhat more expensive than plaster over wooden framing. These hollow blocks provide an air space in the walls, which helps to make the house less susceptible to outside changes in temperature. They are also of some benefit in preventing the passage of moisture through the walls; but they do not entirely obviate this difficulty, as they are popularly supposed to do. The method of manufacturing such blocks makes it necessary to use a smaller amount of water than is required for maximum density, and, as a result, the blocks are very porous.

Concrete and stucco are especially suitable for porch construction. Since porch floors, supporting walls, and steps are subjected to great exposure to weather, they should be of permanent construction. Materials particularly satisfactory in porch design and building have an added value for farmhouse use.

Stucco is also effectively used in remodeling farmhouses. This is done by what is called "overcoating," or simply applying a stucco finish over the old walls. This may be put on over the old weatherboarding, or the old covering may be removed and the metal lath applied to the sheathing or studding. This is an economical and satisfactory method of making a new house out of an old one. With the framework of the house in good condition, the result will be a building attractive in appearance and having all the essential qualities of an original stucco house. This method of remodeling eliminates the cost of painting and outside repairs.

**Stone.** The expense of construction with stone is so great as to be prohibitive of the use of that building material for farmhouses, if the cost of the house is to be kept within its proper proportion to the total farm investment. Even with the stone at hand, the expense of quarrying and dressing it, combined with the slower and more difficult

construction required, will make the total building cost about 25 per cent above that for a wooden house. Field stones imbedded in cement make a substantial wall construction, cheaper than dressed stone. However, there are only occasional localities and conditions where this can be used. It is picturesque in effect, and demands special designing and combinations with other materials. It cannot be considered a standard or typical wall material.

**Combinations of materials.** Two or more of the various building materials may be advantageously employed in the same house. These combinations may be dictated by the architectural effect desired, by the outlay permitted, or by the available supply of the different sorts of material. Brick combines so well that it is nearly always found where more than one medium is used. Brick and wood form a very acceptable combination, where it is necessary to keep the cost below that of an entirely brick house. Brick and stone combine well, but make an expensive building. Brick and stucco give a good combination, and are hardly more expensive than brick and timber.

Recoating with brick for the lower story and with stucco or half-timber for the upper one is quite practical, and the results are good artistically. Brick and shingles, hollow tile and shingles, stucco and shingles are combinations often found. They are all satisfactory, and the determining factor of their choice should be local conditions affecting the supply of material or labor, or personal preference as to appearance. Combinations including shingles are especially good for Dutch Colonial designs, as in these the second-story walls are really roof surfaces. Different materials should be combined only in large or medium-sized houses, as the dividing lines break up the surface areas and decrease the apparent size.

## Things to Remember in Planning the Farmhouse

The plan of the farmhouse must be based upon the daily program of the farm family. This differs in many essential points from that of town or city dwellers, and the differences should be kept constantly in mind in planning the farmhouse and its accessories. The demands made upon the time and energy of the members of the farm household are controlling factors in fixing their mode of living and in determining the material needs of their home arrangements. The chief business of farmer folk is work; and this usually injects itself, in some form or other, into all the hours of the day. The house is an all-day workshop. The country housewife cannot separate her hours of domestic duties from those given to social exactions or devoted to recreation and culture, as can the town woman. These all go along intermingled through the entire day. For this reason, the parts of her house devoted to these ends cannot be distinctly defined and set apart, as in the town house.

**Consider the housewife.** The plan of the farmhouse should look to such arrangements as will enable the housewife to meet the varied demands upon her with the least expenditure of time and energy. Very often the entire work of a farmhouse establishment falls upon one woman; if she have help at all, it is but occasional and meager. Only the most complete equipment and the most skillful arrangement of conveniences will make it possible for one woman to carry all of this and successfully meet all of the demands upon her vitality, strength, and resourcefulness. The plan of the farmhouse should be drawn to this particular end.

The numerous tasks and duties of the country housewife consume so much the larger part of her time and powers that, for her, the usual proportion between work and social pleasures for women is reversed, and so, also, is the relative importance of the living and service parts of her house. Her parlor is for occasional use only; her kitchen is the centre of her activities, and is usually occupied from dawn till dark. The house arrangement should be compact, with few halls and passageways, to save her steps and to enable her to carry on, or oversee, activities in different rooms at the same time. She may drop down in an inviting rocker in the living room and read the paper while waiting for the men to come from the fields for dinner, if the living room and kitchen adjoin, enabling her to keep an eye on dinner while waiting.

**Use porches as much as possible.** The farmhouse should be so planned that the family may live more on porches than in closed rooms. Every farmhouse should have a dining porch and provisions for outdoor sleeping. The dining porch, of course, must be screened against flies; and this will also shut out the dogs, cats, and chickens. This porch will, probably, very soon become the living porch, also. Many farmers, in planning their houses, omit porches because of the expense. It is true that the cost of a porch is about that of a room; but the service and benefit derived from a porch is not equaled by that of any room except the kitchen. The porch, fitted with hinged or removable sash to be used in cold weather, makes a comfortable and most attractive living room in all but very severe weather. With large inclosed porches, some rooms may be omitted or reduced in size, so that the porch need not really add much to cost of the house. The porch extending from the house and exposed on 3 sides gets more of the summer breezes than the built-in kind; but it costs more, and is less serviceable in protecting against rain and wind and sun.

FIG. 482. The farmhouse with plenty of porch space offers exceptional advantages, both in summer when the porches may be screened and in winter when they may be glassed in.

The recessed porch between two extensions of the house, or the inclosed one which is made an integral part of the house plan, affords all of the delights of outdoor living without the exposure to wind, sun, and insects accompanying the use of the open porch.

The farmhouse should be completely and effectively screened against flies. This is more important for the country house than for any other, if there can be comparative degrees in anything so imperative. The preparation and handling of food is going on so much of the time in the farmhouse, and occupies such a large and important place in the labor program, that flies are attracted in unusual numbers, so that screening is particularly necessary here. Indeed, the dining porch is utterly impractical unless effectively screened. If the only entrance to this porch be from the *inside*, the exclusion of flies will usually be more complete. Such an arrangement might work greater inconvenience in other ways, however.

## Relation and Equipment of the Different Parts of the House

Because the social life of the farm family is so largely dependent upon its own members, and because home influences and conditions mean so much more for country children than for those who have the varied associations and opportunities of town life, all of the arrangements of the farmhouse should be conducive to easy sociability. They should provide constant conditions favorable to the natural injection of this spirit into whatever is doing about the home. The different parts of the house should be so related and equipped as to invite to pleasant companionship, and to offer, naturally, in the day's routine, the pleasures and comforts of a genuine home life.

**The living room.** There should be a large, airy living room with an open fire. This room should be centrally located and on the general lines of passage to the other parts of the house. A very desirable arrangement is to have the other downstairs rooms open-

ing from this general room. The members of the farm family are usually tired at night, and they will not go out of their way to find sociability or diversion, but, if these are at hand, their benefits are reaped without extra exertion. This room, if sufficiently large, may well be a combination living and dining room. This arrangement, too, avoids the expense of a partition wall, saves steps for the housewife, and provides pleasant surroundings for the family meals. It is especially practical in connection with a dining porch, because the porch will be in use during the season when there may be many farm hands to be fed.

It may be objected that it will be difficult to keep this room clean on account of so much passing through it and because of its many uses. It certainly will entail no more work to get rid of dirt from 1 room than to clear away the same amount scattered over 2 or 3. Besides, the point of attack for indoor cleanliness is outside the house. If there are walks about the doors and yards, and provisions for cleaning muddy or dusty shoes and clothing outside, or for leaving them in an anteroom, no great amount of dirt need be brought into the house.

A very satisfactory arrangement is to have a small parlor, or annex, opening into the living room by double doors, so that the two may be thrown together, when necessary. This will supply the reserve accommodations, ready and near at hand, for use on more ceremonious occasions, or when more room is needed. This will also be a comfort to the housewife; for the room can easily be kept clean and in order and ready for the chance visitor. It will also make possible a desirable degree of privacy in the entertainment of visitors or among the members of the family. This latter is a much neglected provision in country homes; too often it seems impossible to have converse with the farmer, or with any of the household, except in the presence of the hired man and of every member of the family.

The general living room should not be a bedroom: the quality of both is lost by this arrangement. Inconvenience and discomfort result, and the real centre of the home-life influences is destroyed.

The living-room-dining-room combination is a very satisfactory one for the farmhome, but the dining-room-kitchen combination is one to be unreservedly condemned. The only recommendation that the latter ever had was that it saved the housewife some steps. If the dining room opens directly into the kitchen, there is really very little to this claim, especially as the kitchen must be larger, to be used this way. Besides, the strength exerted by the housewife outside of the kitchen, to the end of maintaining dining quarters for her family, cannot be better used. Economy of labor should be applied to some of the less important demands upon her.

All meals should be eaten in attractive, congenial, uplifting surroundings, for we seem to feed our souls as we do our bodies. The atmosphere in which we take bodily nourishment supplies at the same time in some subtle way, a food element for our spirits; and its quality goes to the essence of our natures. Kitchens at best are cluttered and unsightly after the preparation of a meal, and at no time does the equipment present an inspiring or restful appearance. In the summer time, the kitchen is the hottest and most uncomfortable place about the house, and the family should not be asked to take their meals there.

**The breakfast alcove.** When there is no help and the family is small, the breakfast alcove, flooded with the morning sun, is a pleasing and labor-saving addition. This is especially convenient for winter use, when

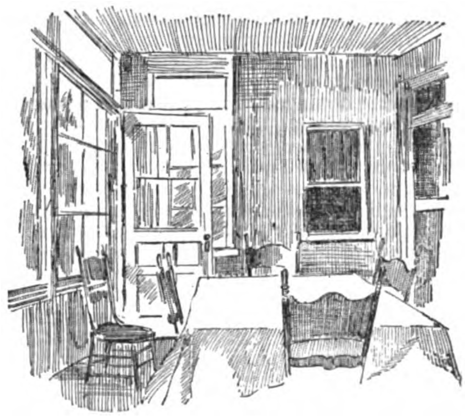


FIG. 483. A sunny breakfast porch is a boon for the family the year 'round, and an added benefit in harvest time when extra hands are boarded.

coziness and warmth are at a premium. It may become quite comfortably warm, from the kitchen range, before the fire is well started in the dining room.

**The stairways.** The stairway should go up from the living room or from a front hall. There should be a separate back stairway, or a short flight leading to a landing of the front stairs, so that access to the upper story may be had from the back part of the house without infringing upon the privacy of the front rooms. The need of this is evident when we consider that the farmhouse must often accommodate the family, visitors, and the hired help all at the same time. The cost of stairs is not great enough to weigh against the convenience of having them where needed. A very good flight of stairs may be had for $100, and simpler ones may run as low as $50. Box stairs for cellar or garret need not cost over $20 or $25.

The right construction of the stairway is a very important matter but one very often

disregarded. The stairs are often made to fit into a certain space instead of an adequate space being provided for hygienic stairs. There is, so to say, but the fraction of an inch in difference between an easy stairway and a difficult one. Stair-climbing even at its easiest, is hard physical exercise and very wearing on women. The steep stairs of many small houses are responsible for countless cases of illness.

The height of the step on all proper stairs is about 7 inches; it may vary an eighth of an inch, but not much more. The tread, *not counting the nosing*, is exactly 10½ inches broad; that is, the notch on the horse is this size. This is the best possible stair proportion for the average person. A steeper one is too steep, and needs an unnaturally great muscular effort; one less steep is tediously slow to climb. One rule that has been developed to govern the proportion of stairs is that the sum of the rise and the tread shall lie between 17 and 17½ inches. Since the natural stride will not vary greatly, the one dimension should not be materially increased without decreasing the other by the same amount. Another good rule is that if rise and tread be multiplied together, the result should not be less than 70 nor more than 75 inches. This ideal proportion for domestic stairs does not, of course, hold for all stairs.

**The bedrooms.** There should be, at least, one downstairs bedroom, for the convenience of the family. The farmer is more subject to night calls than the town resident, as he must see to the comfort and well-being of his stock and poultry besides attending to the numerous small interests about the farmstead. Two downstairs bedrooms, opening into each other, or connected by the bathroom or a narrow hall, are really better than one. If there are small children or old people in the family, this arrangement is very desirable. In case of sickness, it saves many steps for the attendant, especially if she is also the housekeeper.

**The bathroom.** The placing of the bathroom is a very difficult problem in any house having but one. It is especially so where there are both upstairs and downstairs bedrooms. The bathroom should be so located as to be easily accessible from the majority of the bedrooms. If the house be a 2-story one and most of the bedrooms are upstairs, the bathroom should be on the second floor. In this case, the downstairs bedroom would be the spare room, used only for the occasional guest or in case of sickness, and consequently, it would be best away from the bathroom. On the other hand, if the family bedrooms are on the ground floor, and the less frequently used rooms are upstairs, the bathrooms should be downstairs. This latter arrangement seems to give the greatest convenience, all situations considered.

Cleanliness and neatness are nowhere more important than in the bathroom. To make these easily attainable, the walls and floor finish should be plain, washable, and impervious to water. Ceramic tiles are extensively used for bathroom floors in all but the cheaper class of houses. They are laid in cement upon a slab of concrete. As all of the work, except the actual laying of the tile, can be done by ordinary workmen, the cost of such a floor is not great enough to stand in the way of its use in so small a room as the bathroom.

**Hired men's quarters.** Many farmers prefer to provide quarters away from the farm home for the hired men, and this is the most desirable plan, when practical. On the vast majority of farms, however, there come times, when it is necessary to have some hired men housed with the family; and a room for this need should be provided when planning the house. This room should have an entrance apart from the family rooms. On the large ranches of the West, bunkhouses are always provided for the ranch hands, and there is no thought of including them in the family arrangements. This is a direct outgrowth of the farming and labor conditions obtaining there.

**The kitchen.** The location of the kitchen, its arrangement and surroundings, present one of the most difficult problems of the farmhouse plan. The kitchen is the "power plant" of the home, it is the workshop of the housewife, and should be her exclusive domain. It should not be a general passageway for the coming and going of all who are about; nor should it be the washroom for the family or for the men.

The kitchen should be well lighted, preferably from the north, as this gives an even light. Casement windows are best; and they should be high enough to permit the placing of working tables or sink under them while

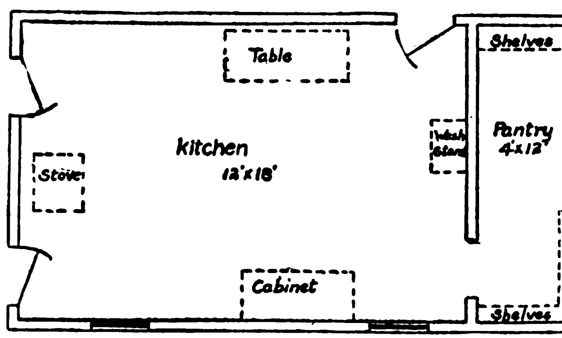



FIG. 484. A farm-kitchen before its reconstruction and rearrangement. Its size and the scattering of its furniture mean miles of walking in doing the daily household tasks. Compare Fig. 485.

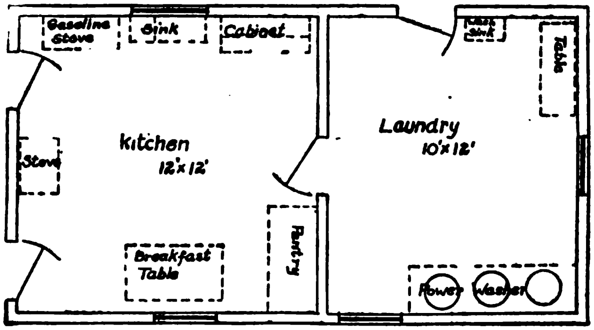



FIG. 485. The farm kitchen shown in Fig. 484, remodeled. Whether used as a dining room or not, the preparing and serving of meals is greatly simplified. The separate laundry prevents much crowding and confusion and provides space for canning and other emergency tasks.

escaping the whipping back and forth of the window curtains over the table top or in the face of the worker. There should be such a relation of its doors and windows as to provide cross drafts, to carry out the odors and smoke. If the windows are in the north, there should be a south door through which the breezes may come. There should also be a flue vent for carrying off the fumes. With these arrangements, the usual butler's pantry, interposed between the kitchen and dining room to prevent the odors penetrating to the rest of the house, may be omitted, thus saving steps for the worker. A built-in dresser or sideboard, with doors opening in both dining room and kitchen, permits prepared food to be passed to the dining room and the soiled dishes to be removed to the kitchen with a minimum of labor. This is also a convenient provision between the kitchen and the dining porch. The kitchen and the dining room opening directly into each other give the most convenient as well as the shortest route from kitchen range to dining table. An intervening pantry with two doors usually means two corners to turn, and this means an added expenditure of physical strength.

**The kitchen entrance.** The kitchen should be near the main entrance of the house and should be easily accessible from it. A good plan is to have a small entrance and stair hall, upon which open the kitchen, the living room, and the dining room. Then practically all of the passing in and out will be through this way, and the unused front entrance and the abused kitchen entrance will be done away with. The fact that nearly all approach to the farmhouse, by visitors and family alike, is to the side or back door is the logical consequence of prevailing conditions there. The kitchen is the centre of activity of the house workers and the place where they are the greater part of the time. It is as logical to go there to find them as to go to a professional man's office to see him during business hours. Also, the kitchen is the room from which produce is loaded to be taken to market, and it is the unloading place for groceries and general supplies brought home from market; so that it is perfectly in keeping with local needs that the entrance near the kitchen should be the main approach to the house. This does not mean that the front entrance should be less attractive, but that the back one be more so; or rather, that they be combined into one both useful and inviting. However, the kitchen should have its own back door, opening into a small back yard, not approached by a driveway. This door should have a small work porch—a cool, secluded place, where many kitchen duties may be performed. There should also be a place to keep the garbage can and the swillpail, if the lack of more sanitary provisions render these necessary.

The popular kitchenette is not so well suited to the farmhouse as to other homes, unless it be helped out by a generous pantry, storeroom, and bin space. The country kitchen and pantry must provide storage space for large quantities of supplies for everyday use; otherwise, too frequent trips down and up the cellar steps will be required. With this provided for, the kitchen should not be large. For the greatest efficiency a kitchen should be only large enough to enable the workers to move about easily without interfering with each other. The sink, the table, and the stove should all be within immediate reach of the worker, or, at most, only a few steps apart. Much floor space, after all of the fixtures and equipment are placed, simply means unnecessary steps and wasted labor. The size of the kitchen must be determined, of course, by the number of workers it is expected to accommodate; but, in the average farmhouse, 12 by 14 feet will leave ample space, after all of the conveniences are installed and the built-in cupboards and dressers completed. The more compact the arrangement, and the more services one piece of equipment is made to fill, the less the work required.

The interior finish of the kitchen should be plain and simple. There should be no fancy moldings or ornate paneling, with grooves to catch dust and greasy vapors and thus add to the difficulty and work of keeping the room clean and sanitary. Where moldings are used, they should simply be plain 1 by 3 inch strips rounded at the edges. The walls should be covered with some washable material, either a paint that will stand soap and water or a commercial wall covering having a washable finish. Both wall and woodwork should be finished in a light color, preferably white. The floor should be cov-

ered with linoleum, or have a finish which is impervious to water and grease and dust, and which may be kept clean by light moppings. An unsurfaced wooden floor should never be used.

**One level for all rooms on a floor.** There should be but one floor level for all of the lower rooms of the house and the adjoining buildings. Similarly, there should be only one level for the upstairs rooms. Different floor levels, with short flights of steps between rooms, may make a picturesque architectural feature; but they do not belong in the farmhouse, where conservation of the housewife's strength is the controlling consideration. The refrigerator; the pantry or kitchen storeroom; the kitchen fuel supply; the well pump, if running water is not in the house—all of these should be on the kitchen-floor level. Going up and down steps requires much greater expenditure of energy than movement on a plane, and this needless expenditure of strength should not be imposed upon the farmer's wife.

**The laundry.** The laundry, whether connected with the kitchen or in a detached building, should have the kitchen-floor level. Many housewives prefer the detached laundry, and this certainly has advantages in fire protection for the house and in relief from the smell of suds through the dwelling. It is not so convenient when the laundry and cooking must be done by the same person, and it adds a few items to the construction cost. There is no good reason for putting the farm laundry in the basement. This practice is simply a town-house feature carried into country construction without thought as to its adaptability. It merely has the one advantage of being under the house roof and of saving so much expense thereby. But the proper degree of economy in the actual outlay for the farmhouse is only that which is compatible with the best use of the natural advantages of the country. The country-woman should not be asked to go down and up the basement steps to do her laundry work. probably keeping an eye on the dinner cooking above at the same time, and then to carry the clothes, wet and heavy, up the steps to be hung out. The opporunity for drying the clothes in the open air and sunshine should not be foregone.

A paved court, under an extension of the house roof, serving among other uses as a drying yard in stormy weather, is a most comfortable and useful adjunct to the laundry, although not possible where the cost must be kept at the lowest.

**The cellar.** A necessity for the farmhouse is a large, dry, well-ventilated cellar, preferably under the house. It should be planned with the same forethought and study as that given to any other part of the structure, and every detail of its arrangement and construction should be carefully worked out in relation to the house plan. It should contain a fireproof furnace room, large enough to contain a winter's supply of fuel. The space required for this will depend upon the size of the house and the kind of fuel used, but an average size is 14 by 16 feet. More storage room of every sort is needed about the country house than elsewhere. The vegetable and fruit room in the cellar should not be less than 16 by 16 feet for the average

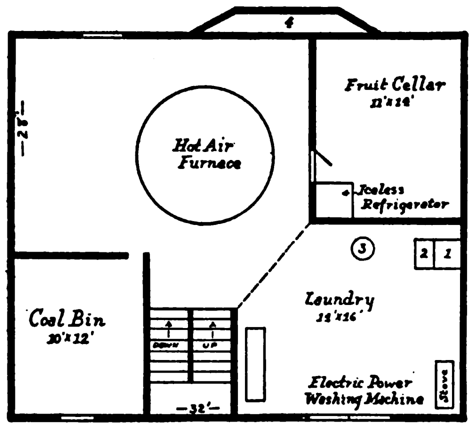



FIG. 486. Cellar plan of prize farmhouse (see Fig. 480). Note Mrs. Freudenberger's objections to the location of the laundry as suggested here.

farm. It should be fitted with hanging shelves and racks, and should be so protected from the furnace room as not to become heated from it. The cellar entrance should be under cover and easily accessible from both the inside and the outside of the house. The cellar stairs should have an easy slope.

**Washroom for the men.** A washroom for the men should be provided, both for their convenience and for that of the kitchen worker. This room should have an outside entrance, and passage from it to the dining room should be by way of a hall or porch, so as to avoid the necessity of the kitchen or living room being made a public passageway. Clothes hooks and hatracks should be placed here. The very dirty field clothes of the men may be exchanged here for more suitable ones for the table, thus saving the carrying of a great deal of dirt into the house.

**The attic.** A finished attic is unnecessary in the farmhouse. It is largely impractical as a storeroom, and the need of conserving ground space is not great enough to warrant the call to climb an extra flight of stairs. The attic space may be made effective in protecting the rooms below from heat, if proper ventilating devices are installed to induce air circulation through it. It is sometimes economical to place flooring over the attic joists for the heat it will save in cold weather.

**Clothes closets.** There are no more

valuable spaces in a house than the clothes closets, yet they are very often omitted from the farmhouse plan. Every bedroom should be provided with a fair sized, well-ventilated clothes closet. Proper ventilation will often prevent the dampness sometimes found in closets along outside walls, especially where the wall construction is poor. Closets need to be carefully planned, because it is the handling of the details of their construction with a view to the efficient use of all the space that keeps their cost down to a fair share of the whole. Ample closets and built-in dressers may often be provided by using spaces, which would otherwise be wasted, under stairways, low roofs, or in angles of irregular houses. Three-cornered closets, or those that project into the room, making extra corners, are not so desirable as those so built as to leave straight, entire wall spaces.

**The fireplace.** No one detail of the farmhouse will mean more for the cheer and comfort of the home than an open fire. All the weight of sentiment is in favor of the fireplace, for the hearthstone is the symbol of the home. Doubtless, sentiment has kept the fireplace in many houses where it was not needed, or was not adequate as a source of heat. Improvements in construction have eliminated many of the annoying defects found in the oldtime fireplace. A fireplace, properly constructed, is an efficient heating device and may take its place among the distinctly utilitarian features of the house. For greatest efficiency, chimneys for fireplaces should be placed against interior walls. This permits the heat absorbed by the chimney to be given out inside the house, instead of being wasted on the outside air. A fireplace designed for use rather than for looks need not be very large. For a small fireplace, an opening 24 by 30 inches is usual, and one 30 by 30 inches will heat a medium-sized room. Larger openings, however, look better, as well as serve better, for larger rooms. The flue opening should contract to about 5 inches in width, and a damper may be placed in this, to reduce it further for economical and efficient heating. There should be an offset, or shelf, just above the throat, to prevent down drafts from driving the smoke into the room.

Fireplaces are efficient ventilators, when in use, and will give valuable service without fires, if the dampers are open. As a decorative feature, the fireplace and mantel, susceptible of such a variety of treatment, have no rival.

## How the House Should Stand

There are certain well-defined principles concerning dwelling houses and their position with relation to the points of the compass; and these are based upon considerations of sanitation and hygiene, as well as upon household routine and the fixed laws of the elements. It is a very simple matter to state these rules, but it is a much more complex problem to plan a house in which all of the desired objects can be attained. In general, the living rooms and porches should face the south and east. The dining room, if used also as the breakfast room, should have an east exposure; otherwise, it may very well be upon the west. The kitchen is best lighted from the north, but it should have a south breeze, if possible. It is most comfortable as a workroom, if placed on the west, so as to have shade in the forenoon. The less used parts of the house, such as halls, closets, storerooms, and stairways, should be on the north and west sides. In these positions, if against outside walls, they protect other parts of the house from cold winds and the hot afternoon sun, and allow the more pleasant exposures for the much-used rooms.

Building tradition and widely established custom to the contrary notwithstanding, a north porch has many merits. It makes a most delightful living room for many months of the year, receiving the early-morning and late-afternoon sun, but being shaded during the heat of the day. Not the least of its delights is the view that it affords of summer sunrises and sunsets. During the few midwinter months, when it is so exposed to the wind and snow as to be of little use as a living room, it protects the house from cold and saves heat and fuel.

**Windows and outside doors.** Windows should be generously provided for in the farmhouse plan, and they should be of medium size and fair proportions. They should be more numerous on the south, east, and west sides, so as to admit more sunshine and less cold wind. If placed too high above the floor, as was common in old-time houses, or made so narrow as to be little more than slits

in the walls, as is sometimes done in cheap houses to-day, they are ineffective for the admission of sunshine into the house. If too large, they appear unwieldy and pretentious; for all farmhouse windows should be made to open, and this is impractical for very large ones. Their height should be so determined as to have the transom, or division between the sashes, come above the average eye-line, so as not to cut in two the landscape seen through the windows.

The grouping or non-grouping of the windows will be determined somewhat by the design of the house, and by the desired distribution of the light within the rooms. It is admitted, however, that grouped windows give more satisfactory lighting results than the same window area scattered. Casement sash are especially good for windows that are high above the floor. These need be only half as large as double-hung windows, to give the same amount of ventilating service. They are simple in construction, may be easily screened, and help to make a pleasing exterior.

Outside doors should be few in number and be placed on the warm sides of the house. They should open on to porches, or be protected by hoods or by small entrances, partly inclosed or not, but always covered. No outside door should ever be made without at least a small platform for it to open on and a roof extension to protect this and the steps. Doors opening on to inclosed porches are best protected.

**The dooryard.** The proper care of the farmhouse and its proper enjoyment are greatly dependent upon its immediate surroundings. The first necessity of these is a dooryard fenced against stock and poultry. This need not be very large, especially the back yard, but it should belong to the house alone. No yard or doorstep can be kept clean and attractive if overrun by chickens; and grass and shrubs and flowers soon give way to such invaders.

FIG. 487. The fireplace is a symbol of home and the family and as such should have a place in the farmhouse. But it is not an efficient heating apparatus

# CHAPTER 31

# Farmhouse Equipment

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AFTER the site of the farmhouse has been selected, its design decided upon, the material of which it is to be built chosen, and its plan and general arrangements settled, there yet remains for consideration the general equipment of the dwelling.

The health, comfort, and convenience of the farm family and, indeed, the actual livableness of the farmhouse, are so largely dependent upon the methods or systems of heating, lighting, water supply, plumbing, and sewage disposal employed, that too much emphasis cannot be laid upon the importance of installing each of these in the best manner possible.

## Heating

The modern farm home (except in the South) is incomplete without a central heating system. The fact remains, however, that a great number of homes are still heated by the more old-fashioned methods of fireplaces and stoves; and it is quite likely that both of these will continue in use for many years to come. The need for efficient heating systems has long been felt; and, with the rapid development of other modern conveniences for the farm home, there has been a coincident increase in the number of modern heating systems installed.

**Fireplaces.** Fireplaces, as a means of heating, are perhaps the most inefficient of all, though a century ago they were accepted as almost standard. The cost of fireplaces, as built in those days, was almost insignificant; for the entire fireplace could be constructed with common labor, which was extremely cheap, and, of course, the materials them-

selves were right at hand and could be obtained at almost no cost whatever. Fireplaces are also exceedingly wasteful of fuel; but, again, in pioneer days fuel could be obtained at no expense other than that of the labor involved in cutting the wood and transporting it to the home. The greatest disadvantage of the fireplace lies in its inefficiency; for, of the heat produced in the combustion of fuel, only a very small per cent is utilized in heating the room in which the fireplace is placed.

Fireplaces are still quite often met with, but they are designed mainly for the cheer which accompanies open-hearth fires. It is true that they may be made quite useful in the late days of fall and in the early days of spring, when the air within the house needs to be slightly tempered, in order to be really comfortable. Another advantage of the fireplace is the ventilation which it furnishes; most of the heated air goes up through the flue and, of course, fresh air must be drawn into the room to replace it. There are on the market special ventilating fireplaces in which a passage extends from the exterior of the house through the fireplace and opens into the interior above the fire; the heat of the fire naturally induces a circulation of air through this flue, and, as a result, warm fresh air is discharged into the room.

**Stoves.** The inconvenience of taking care of fireplaces, coupled with the great amount of dust and dirt attendant upon their use, led to the development of a heating device in which the fire could be inclosed within a receptacle and controlled to some degree. The first so-called stoves which were made to meet these requirements were really enclosed fireplaces, and it required a little experimenting before a real stove was produced. The use of stoves is advantageous because the receptacle containing the fire is included almost entirely within the room to be heated, and the only communication with the outside air is through the smoke pipe; the loss of heat through the stovepipe is quite small when compared with the loss of heat from the fireplace. Aside from the heat lost through the smoke flue, all the heat radiation from the stove is utilized in warming the air of the room. A certain amount of ventilation will result, since, of course, air is required for the combustion of the fuel, and the stove must have a constant supply of a small quantity of fresh air, thus inducing a circulation.

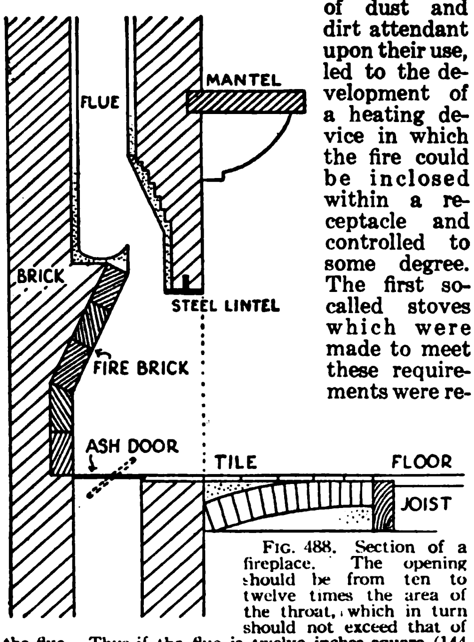



FIG. 488. Section of a fireplace. The opening should be from ten to twelve times the area of the throat, which in turn should not exceed that of the flue. Thus if the flue is twelve inches square (144 square inches) and the throat 36 inches wide, the latter should be but four inches deep and the fireplace opening approximately 42 x 44 inches.

The disadvantage of stoves is the inconvenience of struggling with the dust and dirt which always accompany them. Then, too, it is difficult to heat more than one room with a stove unless an extremely large one is used; and, in such cases, the distribution of the heat is certain to be irregular. The employment of a large number of stoves involves a corresponding increase in the labor of attention; and, where a large house is to be heated throughout, a considerable waste is likely to result.

Stoves are useful for certain purposes and, indeed, sometimes can hardly be replaced, as for water heaters, for laundry and laboratory purposes, and for heating small buildings in which the installation of a more elaborate equipment would be inadvisable from an economic standpoint.

**Hot-air systems.** The difficulty in caring for a large number of stoves, and the loss in economy resulting from their use, brought about the development of what might be termed the first modern heating system, which in reality was simply a large stove, but differing from stoves in that the heat distribution could be definitely controlled.

A hot-air system consists essentially of a heat generator surrounded by a tight sheet-metal case having an inlet for cold air and one or several warm air outlets by means of which the heat is sent through the various portions of the building to be heated.

The cold-air inlet may be within the house at some point near a door or where the degree of heat is of minor importance. It is sometimes connected with the exterior; and, in the best installations, the cold-air duct, as it is called, is connected with both the interior and the exterior of the house, and a damper is installed, so that the air supply may be obtained from either place. The location of the exterior opening of the cold-air duct should not be on the side of the house which is subject to the direct action of prevailing winds; for, in cold, windy weather, the force of the wind may be sufficient to drive more air through the system than is necessary, resulting in a waste of heat. Should this action occur, even when

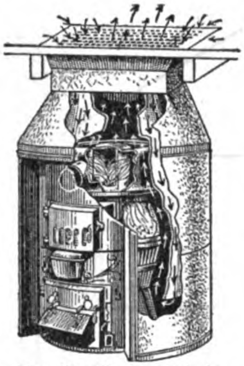


FIG. 489. Pipeless hot-air furnace in part section

the opening is on the protected side of the house, the damper should be turned so that part or all of the air will be taken from the interior.

The warm-air ducts leading to the various rooms are, in the best arrangement, taken off the upper part of the casing from a section shaped like the base of a cone. This permits of a more direct flow of air, and eliminates the sharp turns which are necessary when the hot-air passages are taken off directly from the horizontal top of the casing.

**Size of pipes is important.** The size of the warm-air pipes is important. None should be less than 6 inches in diameter, and for an average room, 8 inches should be the minimum. Since a 10-inch pipe is about the maximum practical size, a large room should be supplied with two. The carrying capacity of circular pipes varies as the square of the diameters and is influenced also by friction, so that two 8-inch pipes are approximately equal to one 10-inch pipe in efficiency.

Warm-air pipes should be covered with insulating material, to prevent loss of heat. Connections between the vertical pipes, or stacks, and the rooms may be made by means of either floor or wall registers. The latter are better in that they are cleaner and interfere less with the placing of furniture; but, the installation of a wall register means another sharp turn in the pipe and a consequent reduction in the velocity of the air flow.

The total cross-section area of the cold-air duct should be about the same as the total cross-section area of all the warm pipes. The former, being one large pipe, has a lower frictional resistance than the combined warm-air pipes. It is usually brought down to the basement floor, and enters the furnace casing at the bottom.

For houses of the bungalow type, or those in which there are large openings between the rooms and open stairways between the floors, the pipeless type of hot-air furnace is easy to install and deservedly popular. Instead of several pipes it has a single duct leading from the top of the casing to a large floor register directly above. From this the warm air circulates through the house gradually cooling, sinking, and re-entering the furnace either through the same register and an outer jacket in the casing, or through a return air shaft built to open either into the cellar or on the main floor. In connection with this type one or more combination floor and ceiling registers may be employed to carry surplus heat from one room to another above, and thereby improve the circulation.

A hot-air system is a desirable method of heating because it is easily cared for and permits full control of the heat distribution. Heat reaches the different rooms just as soon as the air starts circulating, which occurs within a few minutes after the fire is kindled. This system also removes any possible danger of frozen pipes or radiators whether caused by accident or carelessness.

The main objection to a hot-air furnace is that it is dusty and dirty in its operation, especially when the air supply is taken from inside the house. In the latter case, too, there is the possibility that the air, being used over and over, may become poor or "vitiated"; but this can, of course be easily prevented by ventilating. On the whole, hot-air systems are more efficient, cleanly and economical than a number of stoves of an equal heating capacity, but less efficient than the more elaborate steam or hot-water systems.

**Steam-heating systems.** The steam-heating system was the next stage in the development of modern heating systems. The essentials of a steam-heating system consist of a furnace, surrounded by a casing containing water, and a system of distributing pipes. In operation, the water must be brought to the boiling point before steam is produced. Since the system is inclosed, a still higher temperature will produce a small pressure, which will drive the steam through the distributing system. In the rooms

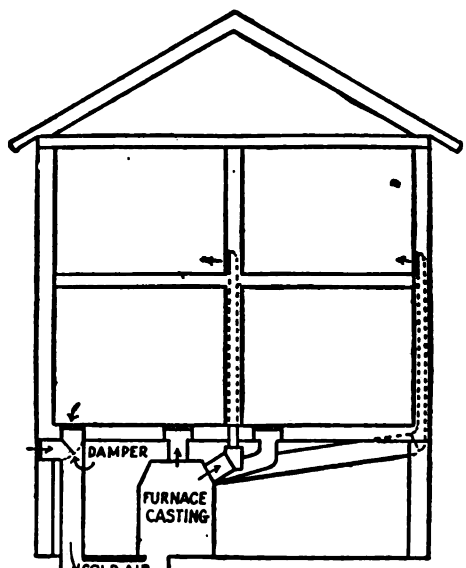



FIG. 490. Diagram of simple hot-air system. It is best to keep all vertical stacks in inside walls where a better circulation of air can be secured

to be heated, the steam is circulated through radiators, where a part of it is condensed in giving off its heat; and this condensation is returned to the boiler and again vaporized.

Various types of steam boilers for heating purposes are manufactured, from small single-unit types to large horizontal tubular boilers of immense capacity. For residences, however, the most popular type is the sectional boiler, which is made of vertical or horizontal sections so combined as to form continuous heat and water passages. The number of sections can be adjusted to meet the heating requirements.

Different kinds of piping systems have been evolved to meet various requirements; the simplest system is known as the 1-pipe system. In this, a pipe is taken off the top of the boiler and carried to within a few inches of the cellar ceiling. From here it is given a pitch downward as it passes around the cellar until it reconnects with the furnace at the bottom. From this pipe are taken off branches or risers leading to the various radiators, being connected to the bottom of the radiator in each case. As many risers as needed may be taken off. The steam is forced up into the radiators; condensing there it returns as water through the same pipes that carried it up as steam.

For very large installations the more expensive and more complicated 2-pipe system may be used. This differs from the single-pipe system in that a separate pipe is provided for the return of the condensed steam. There may be a supply, or flow, pipe and a return pipe for each radiator stack, or a single supply pipe may carry steam to all the radiators, and a single return pipe,

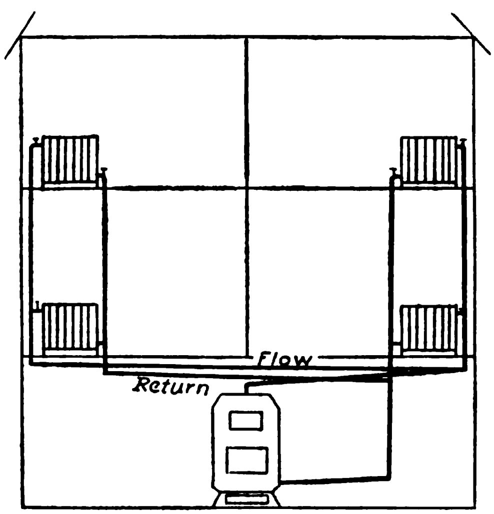



FIG. 491. Two-pipe steam heating system in which a second set of valves and pipes are employed to return the condensed steam to the boiler.

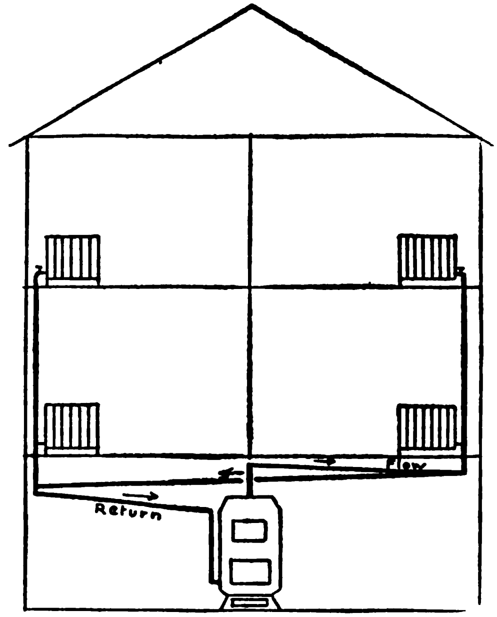



FIG. 492. Single-pipe steam heating system in which the condensed steam returns through the same pipes that first distribute it.

connected with all the radiators, may take care of the condensation.

Vacuum-vapor system. In a modification of the steam-heating system, known as the vacuum-vapor system, certain economy results from the production of steam under vacuum. In a system of this kind, a slight pressure is first developed in the boiler, which drives out the air within the piping through specially designed valves which allow the exit of air, but not of steam. When the air has all been expelled, the pressure is allowed to drop and the steam already in the pipe is condensed, forming a partial vacuum. With this reduced pressure, it is possible to generate steam at a temperature below 212 degrees, thus permitting the circulation of steam at a low temperature with a resultant saving in fuel. It is claimed that the economy effected by the vacuum-vapor system results in the saving of 15 per cent of the fuel used in an ordinary steam-heating system.

The steam-heating system is an exceedingly popular one. It is simple in its operation and, when once the water has been raised to the boiling point, the heating of the rooms is very quickly accomplished. On the other hand, as soon as the temperature of the water drops below the boiling point, the circulation of steam drops immediately and the rooms as rapidly cool. Also, unless the piping system is carefully designed and installed, there are likely to be annoying noises incident to the operation of the system. Even with great

care, knocking is likely to occur, especially where the boiler is overloaded, so that the supply of steam into distant radiators is insufficient; in an effort to furnish the heat required, the steam is condensed too rapidly, a slight vacuum is formed, and the incoming rush of steam to fill the vacuum causes knocking in the radiators and pipes.

**Hot-water-heating system.** In the hot-water-heating system, the boiler and all the distributing pipes are filled with water, and the whole body of water must be heated. Of course, the circulation of the water will begin as soon as heat is applied, because that portion of the water adjacent to the fire-box walls will become heated and will decrease in density and flow upward, and other water will flow down to take its place. In this respect, the hot-water system is superior to the steam system. It takes longer to get up heat with the hot-water system because a considerable period of time must elapse before the water is heated to a temperature high enough to insure adequate radiation.

The piping methods employed for hot-water systems are quite similar to those used for steam except that the 1-pipe system is usually not practicable except in very small installations, and then only when large pipes are used; for both the flow and the return must be carried on in the same pipe. Two pipes are therefore commonly used in hot-water heating, in order that there may be a complete and positive circulation; and connections are made with top and bottom of radiators to further facilitate circulation. One essential feature of the piping system for hot water is the inclusion of an expansion tank located above the highest radiator; for, since water increases in volume with increase in temperature, some means must be provided in which the expansion can be relieved. Sometimes the tank is closed, and provided with a safety valve regulated for a few pounds' pressure. The additional pressure simply results in increasing the temperature of the water, and this permits of the use of a smaller amount of radiating surface. As in the case of any safety valve, this part of the system should be inspected occasionally so as to be sure it is in working order.

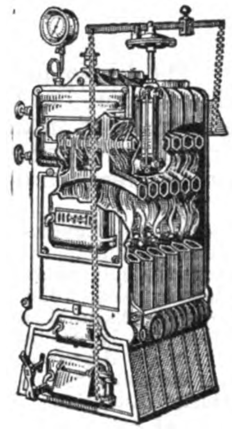


FIG. 494. Sectional type boiler for steam or hot water heating system

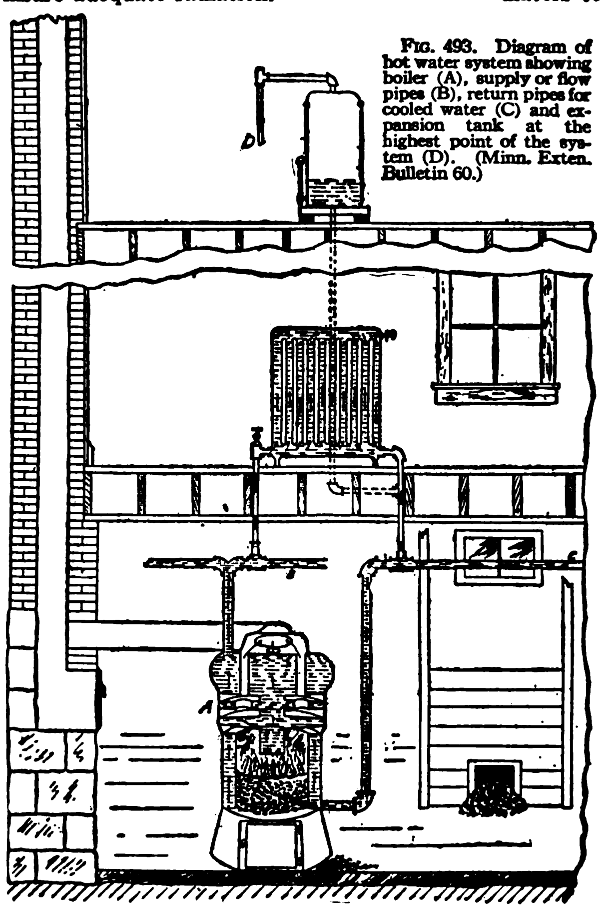



FIG. 493. Diagram of hot water system showing boiler (A), supply or flow pipes (B), return pipes for cooled water (C) and expansion tank at the highest point of the system (D). (Minn. Exten. Bulletin 60.)

In operating a hot-water system, it is advantageous not to drain and refill it oftener than is really necessary. When water is heated a sort of sediment or "precipitate" is likely to form in it and this, accumulating upon the inside of pipes and radiators gradually reduces their efficiency. The oftener fresh water is added, the more of this sediment there is likely to occur.

**Radiators.** The radiators that are used in the steam and hot-water-heating systems are made either of cast iron or pressed steel, the former being much the more common. They are made in almost every conceivable size and shape, so as to fit every possible condition. They are made also in various designs, from perfectly plain ones to those highly ornate.

## Lighting

The development of modern lighting systems has been a rather slow evolution, though more has been accomplished within the last half-century than had been accomplished in all preceding time. Development has been chiefly along the line of perfecting a few ideas, rather than in the originating of a number of entirely different projects.

**Candles.** Candles are still used as a means of illumination. They were for many years the only means of lighting available for pioneers; and, while inefficient, they possess a certain charm of their own in that the light is necessarily produced in small units. To obtain any degree of illumination from them, it is requisite that the lighting units be rather widely distributed, thus preventing bright glare at any one point. Candles are made principally from tallow or from paraffin wax, the latter being a petroleum product. They are made in various sizes and are usually sold by the pound. Their chief use in modern times is, to a very small extent, as portable lights and, to a greater extent, for decorative lighting in residences.

**Kerosene.** The use of kerosene as an illuminating oil began about the middle of the nineteenth century, when the kerosene lamp, so familiar to all, was first invented. It was for perhaps 50 years an almost universal means of illumination in residences; and even yet in rural districts it is very widely used. The light furnished by a kerosene lamp is yellow in color and of a not particularly desirable quality. It is cheap, however, but the care of the lamp is an annoying and an inconvenient feature.

Kerosene may be burned in a lamp provided with an ordinary wick burner in which the oil is carried up by means of capillary action. A more efficient method utilizes the vaporization of the oil, combustion occurring within a mantle, thus forming an incandescent burner similar to that used with ordinary illuminating gas. The disadvantage of the latter method lies in the difficulty of vaporization of the comparatively heavy kerosene.

**Gasoline.** Many attempts have been made in recent years to utilize gasoline for lighting purposes, with more or less success. Since gasoline is a rather volatile oil, it is necessary in order to utilize it advantageously, to vaporize it and mix it with air. It may be used in individual lamps, the base of which is a reservoir for the gasoline and in the burner of which the vaporization and carburetion of the gasoline is accomplished. Such lamps are, however, not at all safe; for the flame is in rather close proximity to the oil itself, and explosions may result.

In addition to lamps, there are 3 methods commonly made use of in the utilization of gasoline as an illuminant; these are respectively known as the "cold" process, the "hollow-wire system," and the "central-generator" system. In the cold process, the air is passed over the gasoline and absorbs the gasoline vapor until it becomes saturated. It is then sent around through ordinary pipes much as any other gas is handled. In the hollow-wire system, the gasoline container is partially filled with compressed air and the gasoline is forced around to the various lamps through a hollow wire and then vaporized in the lamp. Such a system is not very desirable for residence use, since it requires several minutes to get the burner heated up sufficiently to accomplish a vaporization of the oil. The central-generator system is so called because the gasoline is vaporized by heat at a central point and there mixed with air before being sent around through pipes to the place where it is to be consumed. All that is necessary with a system of this kind is to turn on the gas and light it.

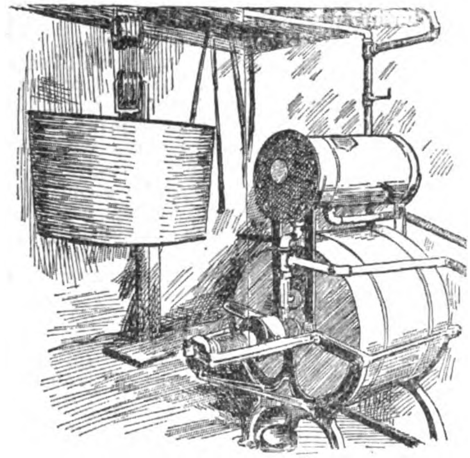
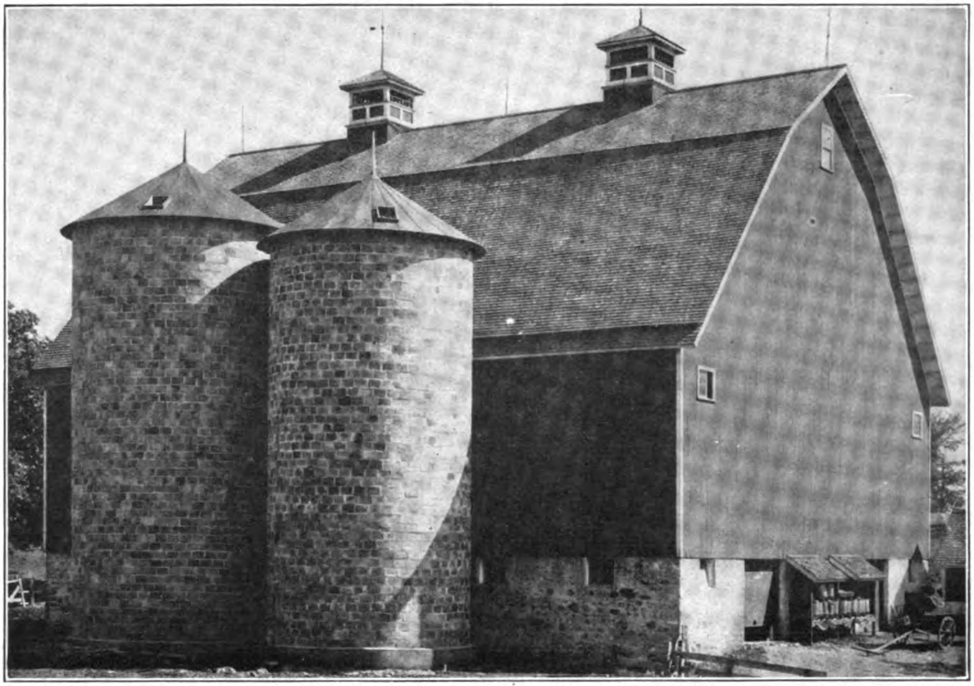
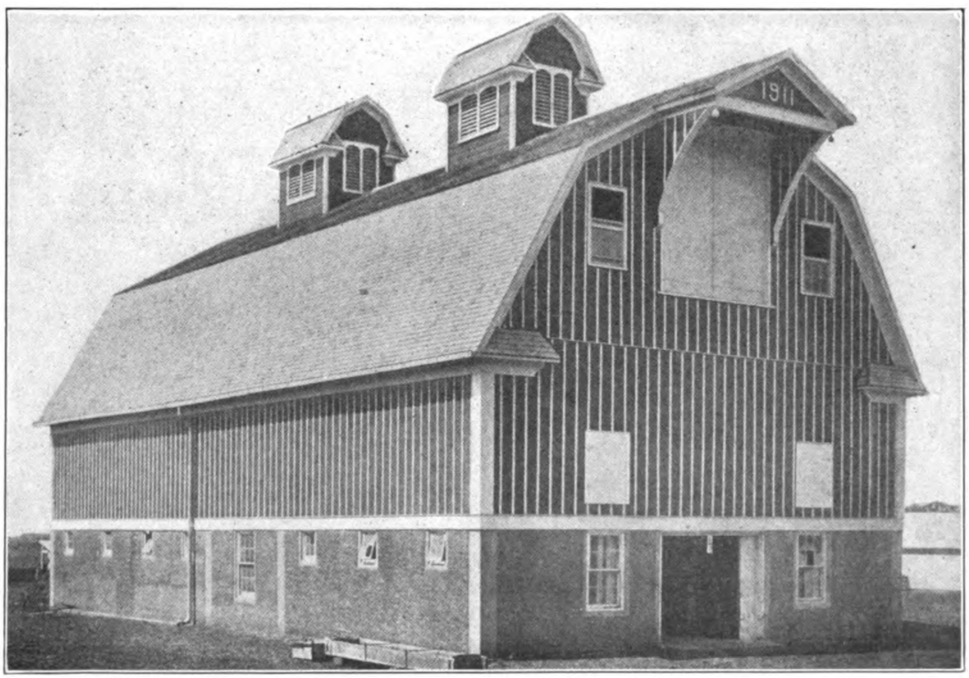


FIG. 495. Gasoline lighting plant. The gasoline stored outside is drawn into the drum-like mixer, vaporized, and distributed through the house, the apparatus being operated by the weight of the metal, rock-filled tub which is wound up like a clock weight at regular intervals.

**Acetylene.** Acetylene is a gas which is generated through the absorption of water by calcium carbide. It is a form of illuminant which has been widely used, not only for isolated installations, but for municipalities as well; and great success has attended its development. The light furnished by acetylene when burned in a mantle is a very fine

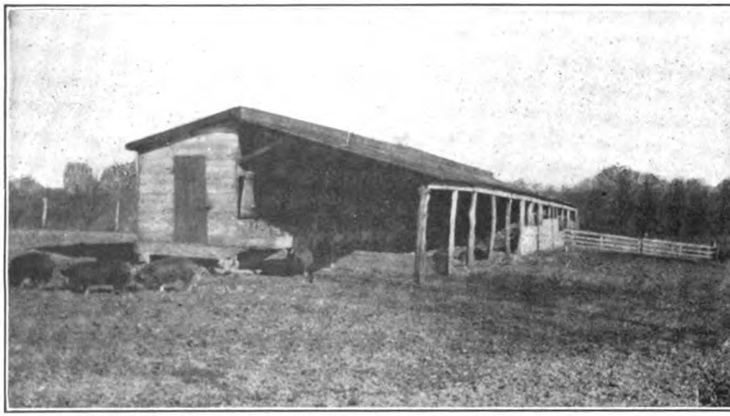


A combination storage and dairy barn eminently suitable for northern sections



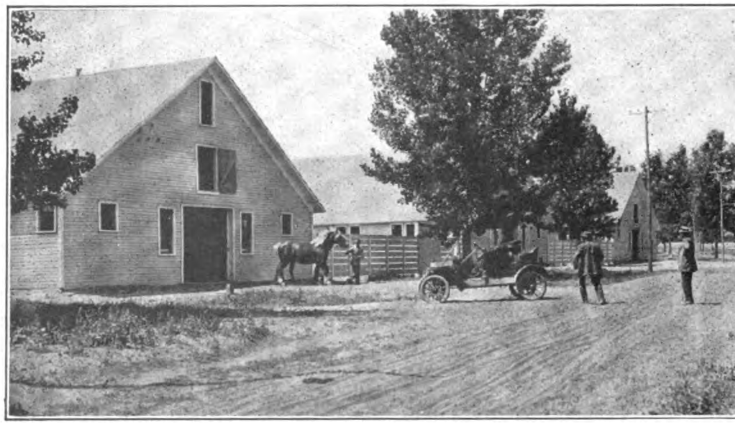

A combination hay and horse barn on a successful, practical, Iowa farm

FROM GOOD BUILDINGS COME PROFITS; AND THESE IN TURN MEAN BETTER BUILDINGS



A feeding shed and shelter for hogs in the field

A feed lot and general feeding barn for baby beef production



Stallion and sales stables on a commercial horse breeding farm

Single-story, concrete cow barn on a farm producing certified milk

THERE IS A BEST TYPE OF BUILDING FOR EVERY PURPOSE. THE FIRST TASK IS TO DETERMINE IT; THE SECOND, TO BUILD IT CAREFULLY AND WELL

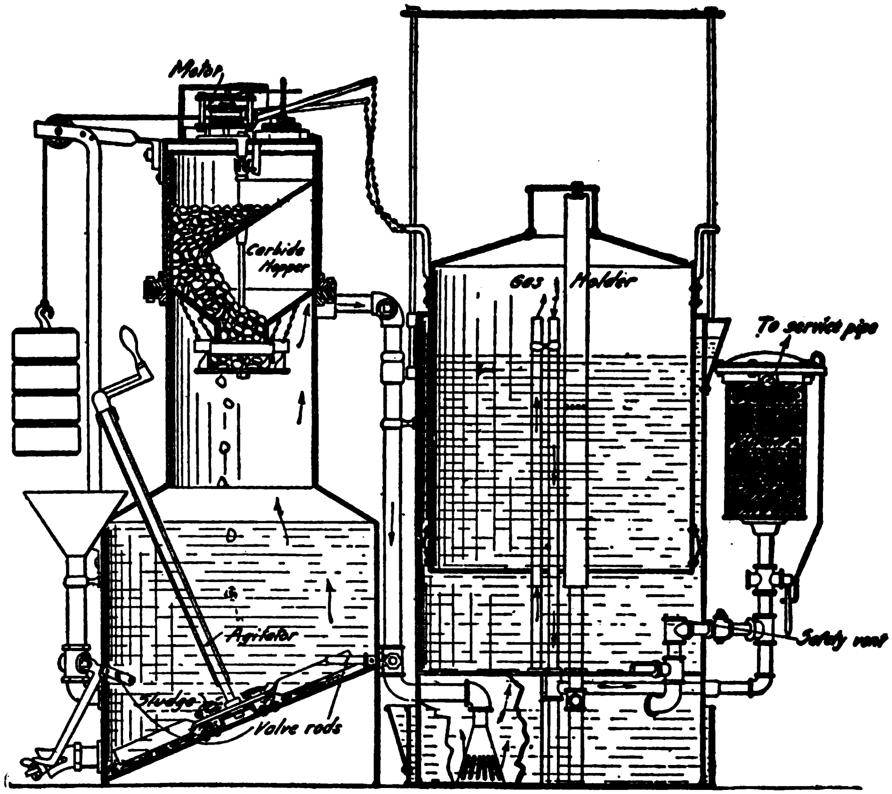



FIG. 496. Acetylene gas generator of the two-unit type. The place for this is in the basement well away from danger of frost. (Minn. Extension Bulletin 58)

white light closely resembling sunlight. It may also be burned in the ordinary open burner, but the light then furnished is of a very inferior quality. The advantages of acetylene as an illuminant are that it is cheap, not only in first cost and in installation of the necessary equipment, but also in maintenance. Its disadvantages are that it is dangerous, unless handled with great care, and is not so flexible an illuminant as electricity.

There are two systems by which acetylene is used as an illuminant. One of these is known as the "carbide-to-water system," in which the carbide in rather small pieces is fed into a reservoir of water. It is advantageous in that there will always be an excess of water, consequently the carbide will be fully utilized. Experience has shown that it is the safest system, and practically all installations are of this kind. The other system is the reverse of this the water is fed to the carbide; it is used mainly in small lamps, such as bicycle lamps and the like.

As mentioned previously, acetylene is usually burned under a mantle. The piping should be carefully done, in order that there may be no waste of the gas. In the installation of an acetylene system, every precaution should be taken to eliminate any possibility of an accident. When, from any cause, an excess of carbide is fed in the generator, unless some sort of a safety valve is provided, the pressure may increase to such an extent that spontaneous ignition will occur, with a resulting explosion. Perhaps the safest installation is that made in a pit at some distance from the residence to which the gas is to be supplied. If such a pit be properly made and adequately protected, the danger in the use of acetylene will be practically eliminated.

**Natural gas.** Natural gas, though occurring in many scattered localities through the country, is not a universal illuminant. In regions which are so fortunate as to have natural gas, the fullest advantage may be taken of its use, since it is normally very cheap indeed and, when properly handled, is a very efficient form of light. The only precaution to be taken in the use of natural gas is to make the pipe installation with the greatest care, so that no leakage may occur.

**Electricity.** Electricity for illumination may be derived from two sources: (1) the services of a regular power company, and (2) an isolated system. When power-company service is utilized, the rate is extremely varied, depending not only upon the original cost of the production of current, but upon the distance the current must be transferred and the amount used. Such service, when supplied by a reliable company, is decidedly advantageous and has many points to commend it.

Unfortunately, however, everyone is not so situated as to be able to take advantage of service of this kind. Recourse must then be had to an isolated electric system, which is a very satisfactory method of illumination. This consists essentially of a generator, a storage battery, and switchboard, together with the accompanying wiring system by which the current is carried around to the various points where it is to be used. The size of the system will depend upon the voltage and upon the current required.

Both of these systems have been fully described and discussed in chapter 18 on "Electricity on the Farm."

One of the most recent developments in the way of isolated electric-lighting outfits consists of a combination unit with all the essentials of the isolated system included in such a way as to permit of an automatic operation. When the engine is started, it drives the dynamo as a generator and forces current into the storage battery. As soon as

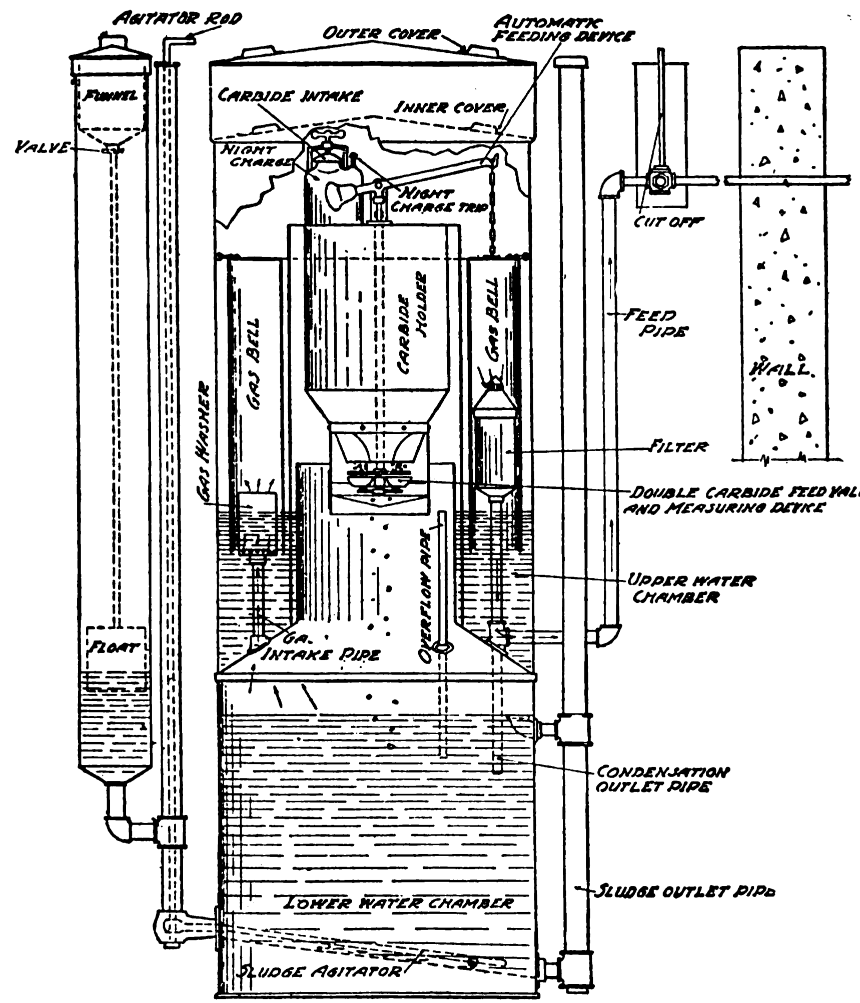



FIG. 497. Single-unit acetylene generator which should be buried in a concrete pit at least twenty yards from the house. (Minn. Extension Bulletin 58.)

the voltage of the storage battery shows a certain reduction, a circuit is closed, which directs a current into the dynamo, operating it as a motor, which, in turn, starts the engine. As soon as the engine is running under its own power, it, in turn, drives the dynamo as a generator and the recharging of the battery occurs.

**Cost.** Investigations conducted at the Kansas State Agricultural College show that, neglecting original cost and depreciation, the comparative cost of operating various systems of lighting for 80-candle-power illumination, is as follows: Kerosene, 0.4 to 4 cents; gasoline, 0.25 cent; acetylene, 1.25 cents. Electricity power-company service, 0.8 cent; in isolated plants, 1.33 cents; city gas, at $1.40 per thousand, 40 cents.

## Water Supply

On the great majority of farms, the water used for various purposes is derived either from wells or from springs; only in comparatively rare instances is it obtained from municipal systems. The dangers attendant upon the use of cisterns, a pond or other reservoir, or an open stream, are generally recognized; and such sources of supply are usually to be carefully avoided.

**Springs.** Springs are generally satisfactory sources of water supply, since the water obtained from them seeps through many strata of soil and porous rock, which act as effective filters. They are of fairly wide distribution, though in plains regions they, naturally, are scarce, owing to the fact that their origin must be at a considerably higher level. The fact that a spring flows full and clear does not insure purity, however; for springs are subject to contamination, not only at their origin, but by coming in subterranean contact with other contaminated streams, and at their outlet. If there is any suspicion as to the quality of spring water, it should be analyzed, to ascertain whether pollution exists or not. The origin of springs should, as far as possible, be carefully examined.

The flowing spring itself requires careful protection, to insure sanitary operation. A good fence surrounding it will exclude stock. It should be dug out and walled up with stone or brick masonry, the water being led into the pit through a screened tile. Perhaps a better material than stone or brick is reinforced concrete. The pit should be, say, 3 feet square and 2 or 3 feet deep, and provided with a cover to exclude leaves and trash, which so often pollute a spring. The water may be conducted to the house through pipes

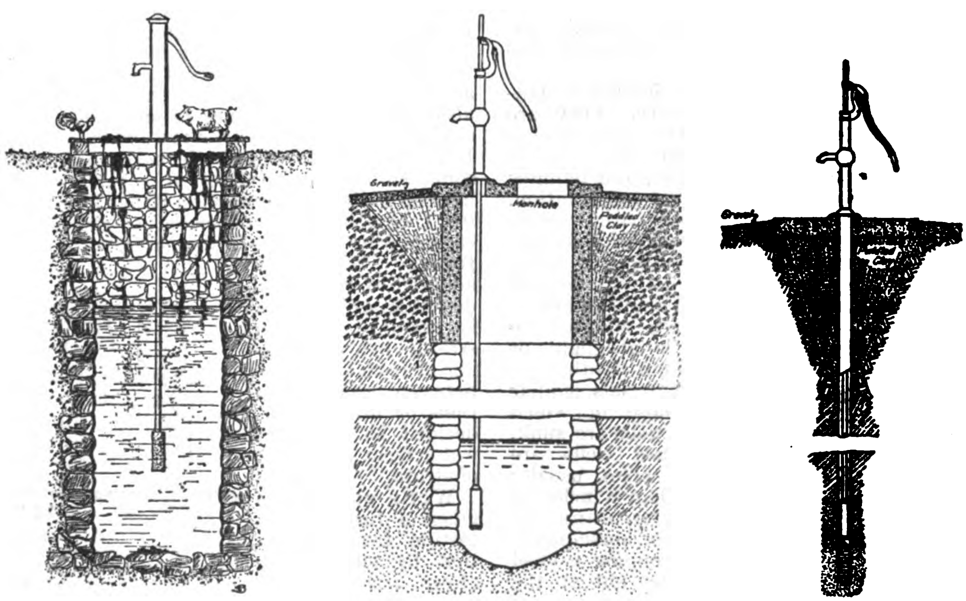


FIG. 498. A badly polluted well (*left*), an all too common sight on the farm; and suggestions as to how to protect both dug wells (*centre*) and driven wells (*right*) from similar trouble. Concrete is invaluable for this purpose

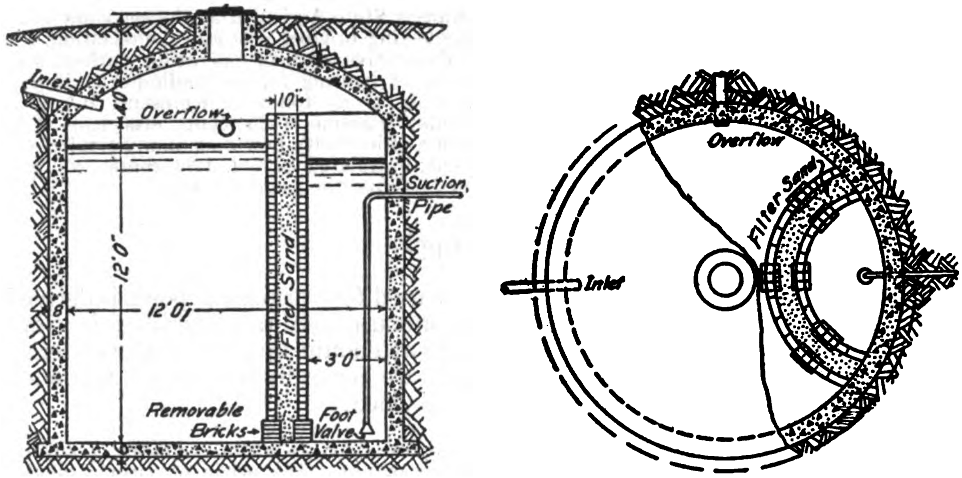



FIG. 499. Section and plan of a cistern with partition filter made of two rows of brick with sand between

by gravity, if the spring be elevated high enough; otherwise, a hydraulic ram may be found advantageous (See Chapter 16).

**Wells.** Wells may be either deep or shallow, a depth of, perhaps, 30 feet being arbitrarily taken as the separating point between the two. Deep wells are usually bored or driven, while shallow wells are more often dug. The former are less likely to receive contamination than the latter, on account of the increased depth of soil through which the surface water must filter before striking the water-bearing stratum.

Fuller, in "Domestic Water Supplies for the Farm," gives the following concise description of wells:

"Dug wells are generally circular excavations 3 to 6 feet in diameter. They are adapted to localities where the water is near the surface, especially where it occurs in small seeps in clayey materials, and requires extensive storage space for its conservation. Bored wells are wells bored with various types of augers from 2 inches to 3 feet in diameter rotated or lifted by hand or horse-power. They are usually lined with cement or tile sections with cemented joints and often with iron tubing. They are adapted to localities where the water is at slight or medium depths and to materials similar to those in which open wells are sunk. Punched wells are small holes, usually less than 6 inches in diameter, sunk by hand or horse-power by dropping a steel cylinder slit at the side so as to haul and lift materials by its spring. They are adapted to clayey material in which water occurs as seeps within 50 feet of the surface, but not at much greater depths. These wells should also be lined with tile, iron tubing, or sheet-iron casing. Driven wells are sunk by driving downward, by hand or horsepower apparatus, small iron tubes, usually 1¼ to 4 inches in diameter and provided with point and screen. They are adapted to soft and fine materials especially to sand and similar porous materials carrying considerable water at relatively slight depths, and are particularly desirable where the upper soil is likely to be polluted.

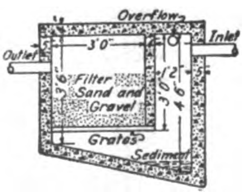



FIG. 500. A small concrete filter that can be used to purify the water supply of any farmhouse.

"Cemented rock or brick linings protect the well from pollution, except at the bottom, as long as the walls are not cracked. They also prevent the entrance of sediments and animals and do not impart a taste to the water. Iron casings are used in both rock and unconsolidated materials. They are usually used in deep wells. They may be either iron tubing 1 to 4 inches in diameter, or sheet-iron casings 4 to 16 inches in diameter, with snug joints. They are adapted to wells of all depths in which water is obtained from a stratum below the casing or from a stratum between cased sections or in case it is decided to procure water from a number of strata."

Wells should be given a further protection from pollution by surrounding them with water-tight curbs, in addition to the casings or

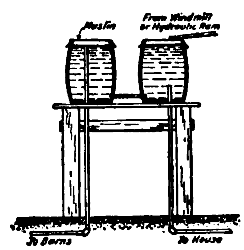



FIG. 501. A simple, home-made arrangement for obtaining clean water and some pressure which, of course, increases with the height at which the barrels are placed

linings mentioned above, and covering with a reinforced concrete cover, which should be 6 or 8 feet square, with an outward slope to carry the water away from the well. It is advisable to lay a circle of tile below the circumference of this cover, into which the surface water may seep, flowing away through a conductor tile to a connection with a regular drain. In this way all surface water may be effectually excluded.

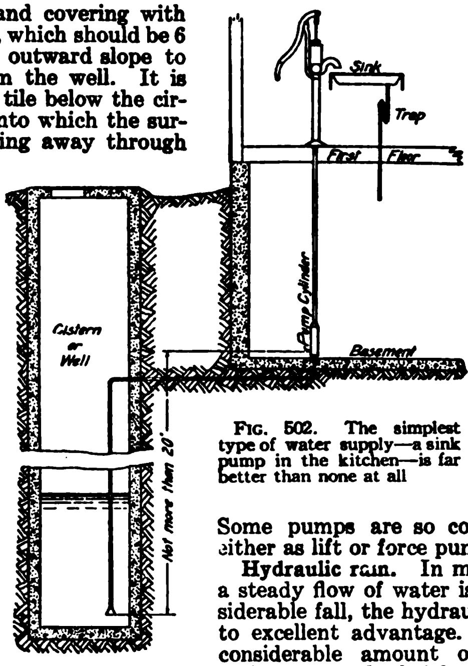



FIG. 502. The simplest type of water supply—a sink pump in the kitchen—is far better than none at all

**Amount of water needed.** In households where an adequate supply of water is available and convenient, and modern pumping systems are installed, the consumption of water is several times as much as where a pump is the only means of obtaining it. This in itself is a fair indication of the value of modern systems. Water consumption varies with the climate, the season of the year, the extent of various household operations, the household equipment, the number of animals on the farm, and the number of persons in the household. Fair estimates of the amount needed per day by each person and animal are as follows: person, 30 gallons; horse, 8 gallons; cow, 8 gallons; hog, 2 gallons; sheep, 2 gallons. From this it is evident that on an average farmstead, with 6 persons in the family, and with stock consisting of 30 head of cattle, 12 horses, 20 hogs, and 20 sheep, nearly 600 gallons of water are required per day; this should be increased, to provide for extra water used for lawn sprinkling, cleaning, and other contingencies, by at least 10 per cent.

**Pumps.** Two kinds of pumps are commonly used in farm wells—the lift pump and the force pump. In the former, the water is lifted by a piston or plunger attached to the lower end of the pump rod. Theoretically, the distance which a pump of this kind should raise the water is a little more than 32 feet, a distance equal to a height of water-column giving a pressure equal to atmospheric pressure; but practical considerations reduce this to about 25 feet.

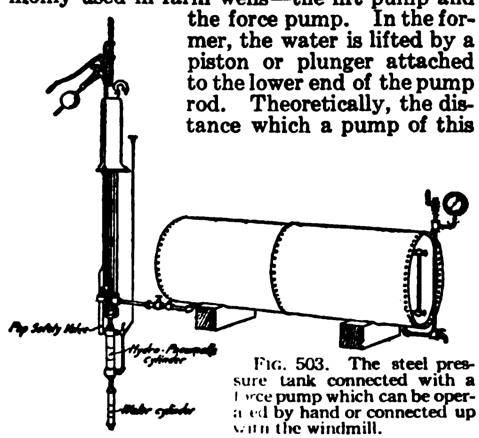


FIG. 503. The steel pressure tank connected with a force pump which can be operated by hand or connected up with the windmill.

The force pump differs from the lift pump in that the raising of the water is done by exerting a pressure upon it with the plunger, the height to which the water can be raised depending upon the amount of pressure exerted. Some pumps are so constructed as to act either as lift or force pumps as desired.

**Hydraulic ram.** In many localities, where a steady flow of water is available with considerable fall, the hydraulic ram may be used to excellent advantage. The ram wastes a considerable amount of water, depending mainly upon the height at which it must be discharged, or, perhaps more correctly, upon the ratio of the depth of fall to the height of discharge. When the ram is operating, water flows through the drive pipe, increasing in velocity until the momentum is sufficient to close the outlet valve. As a result of the impact of the suddenly stopped flow, the discharge valve is raised and a portion of the water is forced into the discharge pipe, reducing the pressure thereby and consequently allowing the discharge valve to fall and the outlet valve to open, when the cycle is again repeated. An air dome is usually connected to the discharge pipe, which provides not only a cushion to relieve sudden mechanical strains, but equalizes the flow at the discharge end (see Chapter 16).

FIG. 504. When the sink is some distance from the stove, a faucet on the boiler provides a handy supply of hot water.

**Elevated tanks.** The elevated-tank system of water supply is a very common one, being used both in large and in small installations. It consists of a tank, located either on a tower, on an elevation of the ground, or in the top of a building, and is connected by properly arranged piping systems, with the pump from

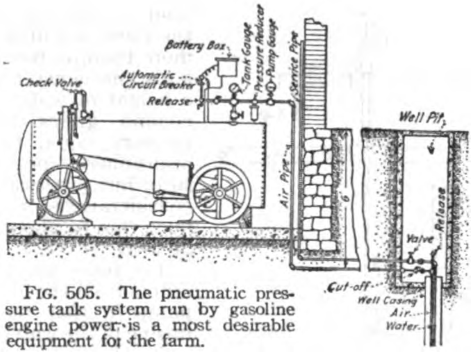



FIG. 505. The pneumatic pressure tank system run by gasoline engine power is a most desirable equipment for the farm.

which water is received, and with the buildings to which water is delivered. It is very simple and comparatively inexpensive, and delivers water at a pressure depending upon the difference in elevation between the tank itself and the point of delivery. It has certain disadvantages, however, in that the water stored in it is likely to freeze in winter and to become stale in summer; besides, a number of accidents have occurred from the failure of tank supports.

A force pump is used to elevate the water into the tank, which should be equipped with a gauge or overflow, to indicate when the tank is filled. The pump may be operated by hand; but when the tank is designed to store a supply sufficient for several days, some sort of a power-driven pump is preferable. The pipes conducting the water to and from the tanks should be of not less than 1-inch diameter. Three-quarter-inch pipe is sometimes used; but the friction loss is so great in the small pipe that it is much better to use the larger size, which costs only a little more originally, and is no more expensive to install. The tank itself may be of wood or metal, preferably the latter; and, where possible, as is the case when the tank is installed on a hill, it is best to make it of reinforced and waterproofed concrete.

**Hydropneumatic system.** In an attempt to produce a water supply system that would furnish an adequate supply of water under good pressure and yet eliminate the bad features of the elevated tank, the hydropneumatic system was evolved. Essentially, it consists of a powerful force pump, an airtight tank, and a distribution system. With all outlets closed, water is pumped into the tank, compressing the air contained therein until the desired pressure is obtained. Then, when any faucet on the distributing system is opened, the compressed air expands, and forces the water out through the opening. Of course, all water pipes are taken off at the bottom of the tank.

Usually, the pump is of the duplex type, and can pump either air or water or both. This is desirable; for it sometimes happens that long use of the tank will deplete the air within the tank, and an additional supply must be furnished. Then, too, it is sometimes desirable to increase the pressure within the tank, in order to have available a large quantity of stored water at a higher pressure. The usual pressure carried in the tank is not to exceed 100 pounds gauge, 70 to 80 pounds being common. The pressure decreases as the water is drawn off, until, when the tank is empty, it is practically nothing. In the majority of installations, the pump is power-driven, using either gasoline or electricity with automatic shut-off; but it is practicable to have hand- or windmill-operated pumps, especially for less expensive outfits.

The tank is generally located in the basement of the residence, where there is no danger of freezing, and where the stored water is kept reasonably cool. From 75 to 80 per cent of the total capacity of the tank is used for water storage, the remaining space being utilized by the compressed air. A tank of from 1,200 to 1,500 gallons capacity will hold several days' supply of water for household use, exclusive of stock requirements.

**Pneumatic system.** The difference between the pneumatic system and the hydropneumatic system lies in the fact that the former does not provide for the tank storage

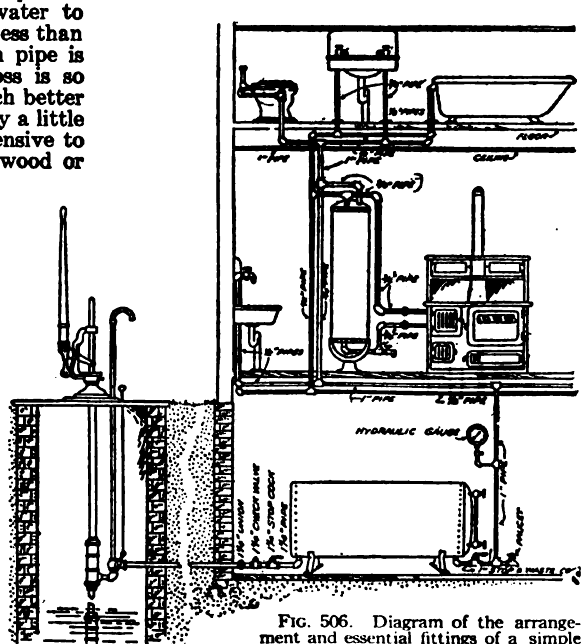


FIG. 506. Diagram of the arrangement and essential fittings of a simple but complete hot-and-cold-water system.

FIG. 507. No wonder girls left the farm when housekeeping meant drudgery like this and worse—

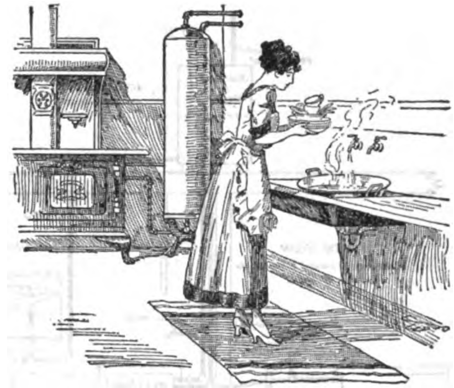


FIG. 508. Especially when simple, inexpensive plumbing can make a kitchen as convenient and pleasant as this

of water, but for compressed air exclusively. The elements of the pneumatic system comprise an airpump, a tank for compressed-air storage, an automatic pump, and a distributing system. The air is compressd by the pump to a pressure generally slightly exceeding 100 pounds gauge and stored in the airtight tank. Thence a pipe leads to the automatic pump, which is a double cylinder contrivance with valves so arranged that when it is submerged in the well or cistern, one of the cylinders is filled with water by external atmospheric pressure. As soon as the filling is accomplished, the compressed air is automatically released, to exert pressure upon the water in this cylinder, driving it through the water mains, while cylinder Number 2 is filling with water. When Number 1 is empty and Number 2 is filled, the action is reversed, the water in the latter being forced out by the compressed air.

This system is the most recently developed of all water-supply systems, and possesses many advantages. It may be used either in dug or in bored wells, successful operation being obtained with the pump located even as deep as 125 feet. The only places that wear occurs are in the air pump and in the automatic pump, but in both cases the worn parts are replaceable. No water is stored, to freeze or grow stale, and a constant supply is possible, the only attention that is required being that involved in maintaining the air pressure in the compressed-air tank; and, with an electrically operated air pump, even this may be automatically controlled.

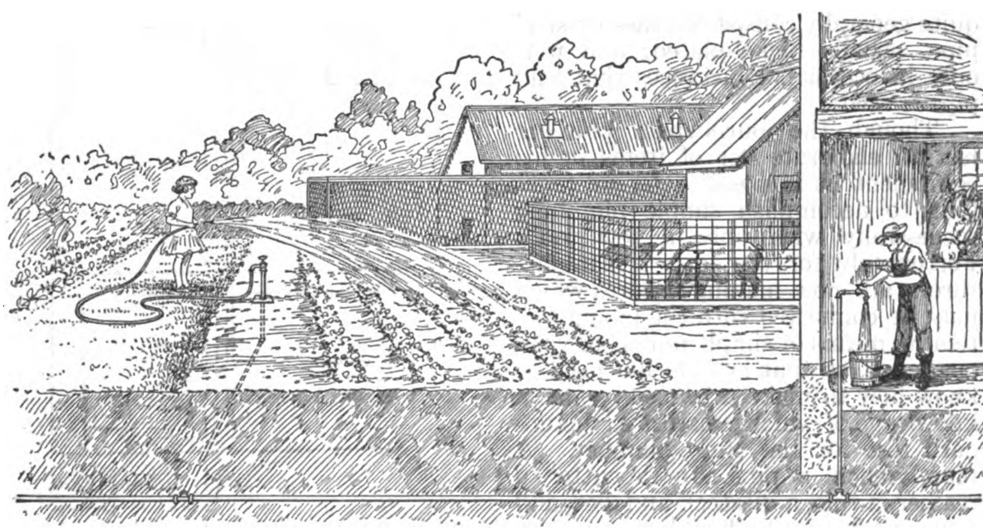


FIG. 509. An abundant supply of good water makes for a better farm and healthier plants, animals and people. It is one of the most profitable of all investments

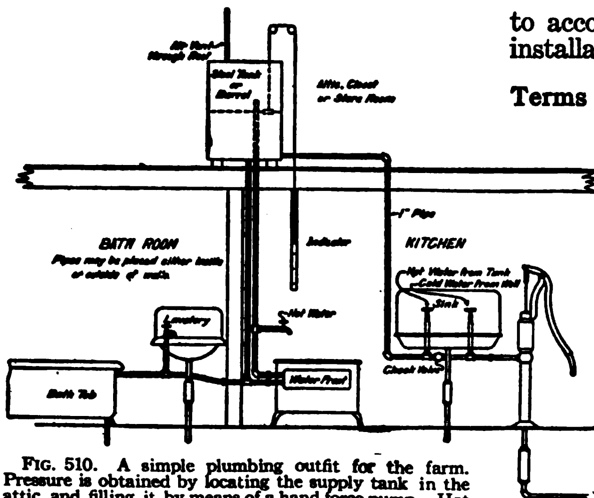



FIG. 510. A simple plumbing outfit for the farm. Pressure is obtained by locating the supply tank in the attic, and filling it by means of a hand force pump. Hot water pipes are shown in black.

## Plumbing

The words "plumbing" and "plumber" have their origin in the Latin word for lead (*plumbum*) since early workers in pipe used lead extensively. Later development has, to a great extent, eliminated lead from plumbing work, though in certain places a satisfactory substitute for it has not been found. Modern plumbing fixtures quite generally consist of brass or steel pipe, usually nickel-plated; and it is only in occasional instances that lead pipe is used.

Though the journeyman plumber has an elaborate list of items in his equipment, it is possible for an amateur to accomplish simple plumbing successfully with only a few tools. Fortunately for the latter, manufacturers are now making fixtures which may be connected with the piping system by means of simple unions of various kinds, so that he does not need to know how to make a "wiped" joint, a knowledge of which constituted a standard test for the early plumber. A pipe wrench, a pipe vise, a cutter, a reamer, a rule, a diestock and dies, and some white lead should, when combined with ordinary skill, be sufficient to accomplish ordinary work in simple installations.

### Terms Used in Plumbing and Their Meanings

**Soil fixtures.** Fixtures which receive human discharges; they include water-closets, urinals, and sometimes slop sinks.

**Soil pipe.** The pipe connecting a soil fixture with the soil stack.

**Soil stack.** The vertical pipe into which soil fixtures, such as closets and urinals, discharge.

**Trap.** An arrangement providing a water seal separating the interior of the house from the discharge portion of the plumbing system. The trap is an essential part of every fixture, for it prevents sewer gas from entering the house.

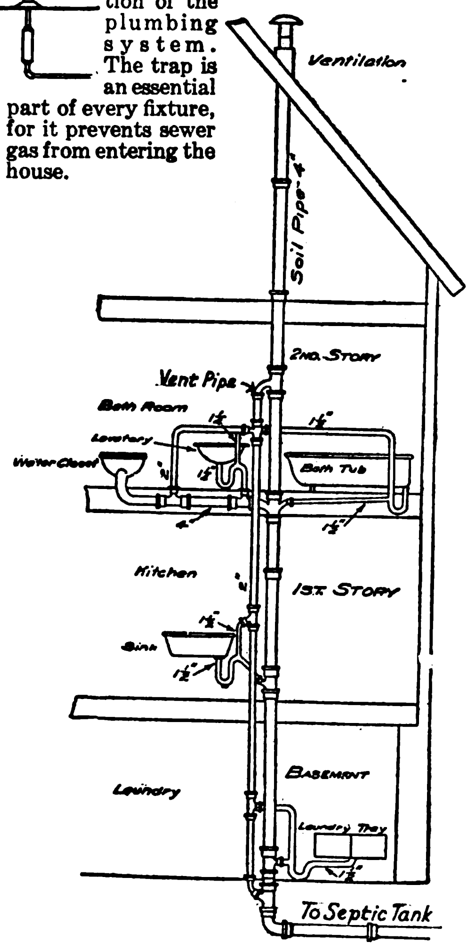



FIG. 511. Complete waste disposal system that can be connected up with a community sewage system or a septic tank as shown.

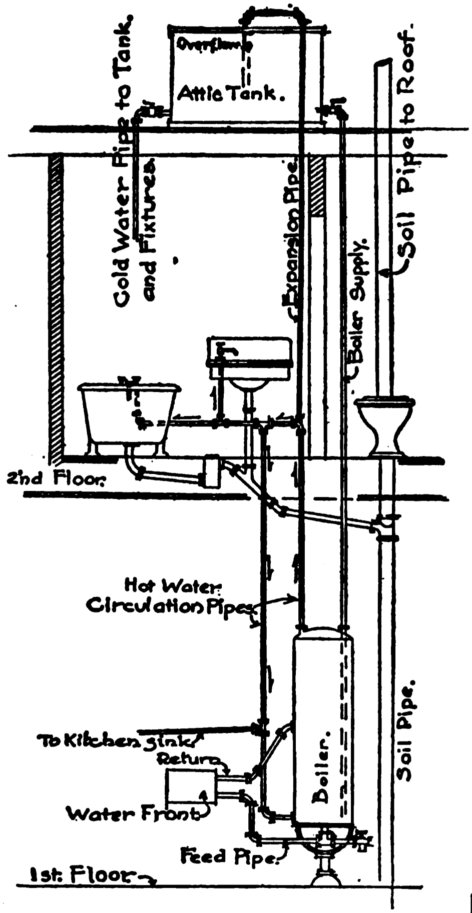



FIG. 512. Somewhat more elaborate plumbing system than that in Fig. 510; in this case the water tank is on the third floor and the bathroom, complete, on the second. Sinks, tubs, etc., are connected with a single soil pipe requiring a sewage disposal equipment.

**Vent pipe.** The connecting pipe between fixtures and the vent stack.

**Vent stack.** A vertical pipe, connecting with the outer air, into which vent pipes discharge.

**Waste fixtures.** Plumbing fixtures, such as lavatories, tubs, sinks, etc., which do not receive any human discharge.

**Waste pipe.** The pipe connecting a waste fixture with the waste stack.

**Waste stack.** The vertical pipe into which waste fixtures discharge.

**Systems of plumbing.** Two systems of plumbing are in common use—the single-pipe system and the 2-pipe system. In the former, 1 pipe is used both as a combined waste pipe and soil pipe and as a vent stack; it is almost universally used in residence installations. The 2-pipe system provides 1 pipe for discharging and a separate one for a vent stack. While theoretically more nearly ideal than the 1-pipe system, it is more expensive and not so practical. Separate waste, soil, and vent stacks are rarely used in residences.

When the single-pipe system is used, it is well to use drum traps instead of the ordinary bent pipes for traps, since the latter are subject to siphonage, resulting from the aspiratory effect of a large volume of water being discharged down the waste pipe, as when a closet is flushed. The seal in traps may fail from other causes, such as evaporation, capillary action when a string or piece of cloth catches on the discharge lip of the trap, or other accidental occurrences.

**Fixtures.** Plumbing fixtures vary in the material used in their manufacture. Bathtubs may be made of solid vitreous ware, which is exceedingly handsome and durable, but expensive. Just as serviceable ones may be made at a much lower cost of heavy, stamped sheet iron, porcelain-enameled on the inside and painted or enameled on the outside. The same is true of lavatories. Sinks are usually made of enameled iron, though more expensive installations sometimes include earthenware slop sinks. Laundry tubs are almost always of plain soapstone. Made of this material, they are more durable and not so likely to become damaged as those of enameled iron. Water-closets are generally manufactured of vitreous ware, their complex shape precluding the possibility of stamping or enameling; and, besides, there must be no danger of their becoming insanitary as a result of chipping, which would be likely in the case of enameled metal.

For sanitary reasons, plumbing fixtures should be as simple in design

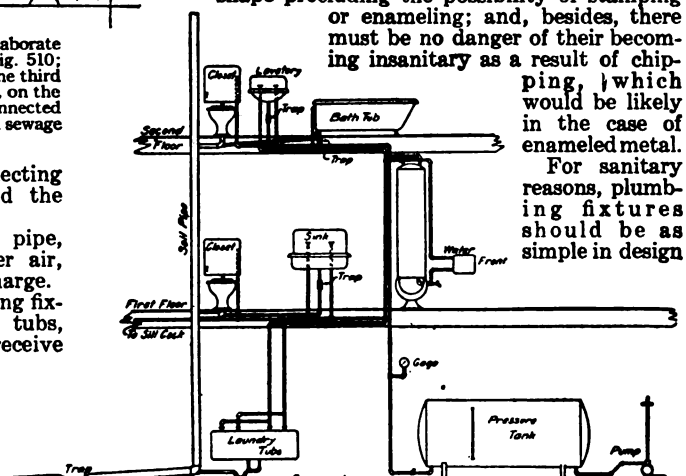



FIG. 513. A system quite similar to that shown above, but in which water pressure is obtained from a pneumatic tank filled by means of a hand-power force pump.

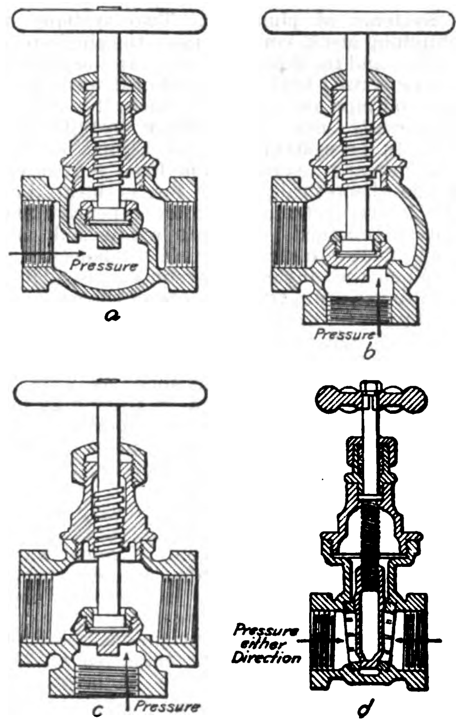



FIG. 514. Commonest types of valves used in heating and plumbing work: *a*, globe; *b*, angle; *c*, cross; *d*, straightway or gate.

as possible. The surfaces should be smooth, so as to admit of easy cleaning; and no acid or substances containing acids should be used on them. The water-closet, especially, should be simple and perfect in construction, should contain no movable parts, and should be furnished with a flange by which an absolutely perfect joint may be made with the soil pipe.

Two types of closets are to be recommended —the "wash-down" and the "siphon-jet." Of these the former is the cheaper; the latter is a newer development and has the advantage of a rapid and an almost noiseless flushing.

**Pipe.** Heavy cast iron pipe, not less than 4 inches in diameter, is used for soil stacks and for connection to the sewage-disposal installation. Lighter steel pipe, not less than 1¼ inches in diameter, may be used for fixtures other than the water-closet. Care must be taken to have the waste pipes at least as large as the outlet of the fixture.

In fitting pipe, measurements should be made carefully, consideration being given to the length of thread, or distance which a pipe will screw into the fitting. Standard dies are made with the thickness of the die equal to the proper length of thread. White lead is used to insure a tight joint, it being spread on the external, *not* on the internal thread, before parts are screwed together. The use of a wheel cutter in cutting pipe leaves a thin rim or burr extending into the pipe and reducing its cross section. This burr should be carefully removed with the reamer as soon as the pipe is cut.

**Requirements.** The requirements of a good plumbing installation may be summarized as follows:

The fixtures must be simple in construction and action, made of good materials, and sightly in appearance.

Tight joints must be made, to prevent leakage of water, waste, or sewer gas. Every fixture must be provided with an effective trap which can be easily cleaned. Pipes must have sufficient slope to insure a rapid, self-flushing flow. Provision must be made for cleaning every part of the system, especially soil and waste pipes that may become clogged.

Care in installation and an occasional inspection are necessary, if continuously satisfactory operation is to be secured.

## Sewage Disposal

Sewage may be defined as waste matter, either excretory or fecal matter or slops, discharged through a system of pipes known as a sewage system. Farm sewage may be of human or of animal origin, or a product of cleansing operations in the household, or waste from the milkroom or dairy.

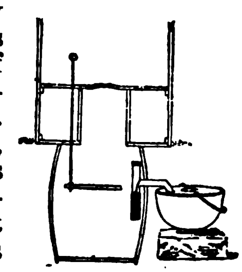


FIG. 515. One of the simplest possible arrangements for human sewage disposal, insuring proper protection of the health of family and neighbors.

The proper disposal of sewage is of prime importance, for several reasons. In the first place, sanitation requires its removal; for sewage may contain elements exceedingly dangerous to the health of individuals or to the community at large. In the second place, sewage contains much that is given off during the process of putrefaction. Finally, common decency requires that no offensive materials be allowed to accumulate in the region of the household or farmstead.

The development of rural sewage-disposal systems has been remarkably rapid in recent years; and it is now entirely possible to dispose of sewage in a clean, satisfactory, and scientific manner with as much success as accompanies the disposal of city sewage. So far as the plumbing installation is concerned, it is the same in both the city and the country homes; but no street sewer is available in the country, as in the city, and other outlets for discharge must be found.

Many dwellings are not equipped with a water supply and plumbing system which permit of the use of a liquid carrier for wastes. It may be impracticable, on the score of economy or for other reasons, to make such an installation; and, in such a case, special methods must be adopted to get rid of wastes.

**Household wastes.** It is possible to dispose of waste from the kitchen and laundry in a satisfactory manner, if occasional care be given to the installation. The simplest way is, of course, to pour it upon loose, porous soil, in different places successively; but this may result in supersaturation, or "water-logging," of the soil, and in summer time may produce a feeding ground for flies. A plan to be more recommended is to employ subsurface irrigation, pouring the wastes out into a system of tile laid with loose joints, from which it seeps out and percolates through the soil to another system of similar tile laid 18 to 20 inches lower, from which it is carried away. Such a system may be made to furnish some moisture to a small garden, or portions of it, without harm. All liquid waste, from dishwashing, cooking, or laundry and cleaning operations, may be discharged into the tile.

**Privies.** Where a water-borne sewage system is not practical, some special means must be devised to dispose of human excremental material. The privy as it is too commonly built is to be abhorred: it is insanitary, offensive, ugly, and sometimes positively dangerous. It may contaminate water supplies, and it affords an ideal breeding ground for flies. With proper construction and supervision, however, it may be made an acceptable and reasonably satisfactory agent in human sewage disposal. It should be well built, with adequate ventilation and with all openings carefully screened to exclude flies.

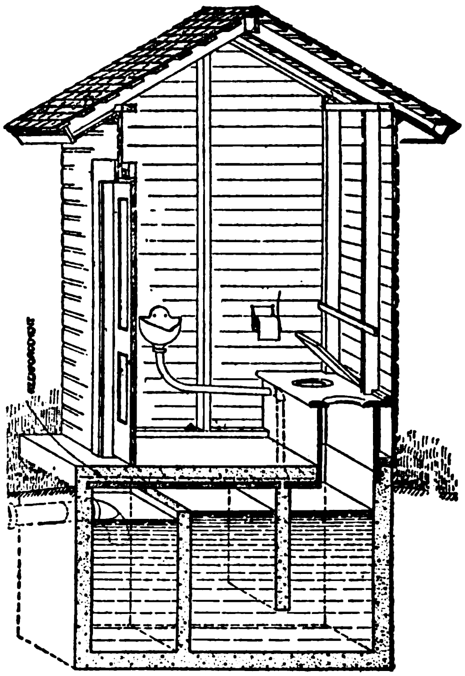


FIG. 517. Septic tank principles applied to a simple privy vault. There is no reason why any farm should be without at least this degree of convenience.

The excrement may be taken care of in 2 ways—(1) by the dry method, which is the

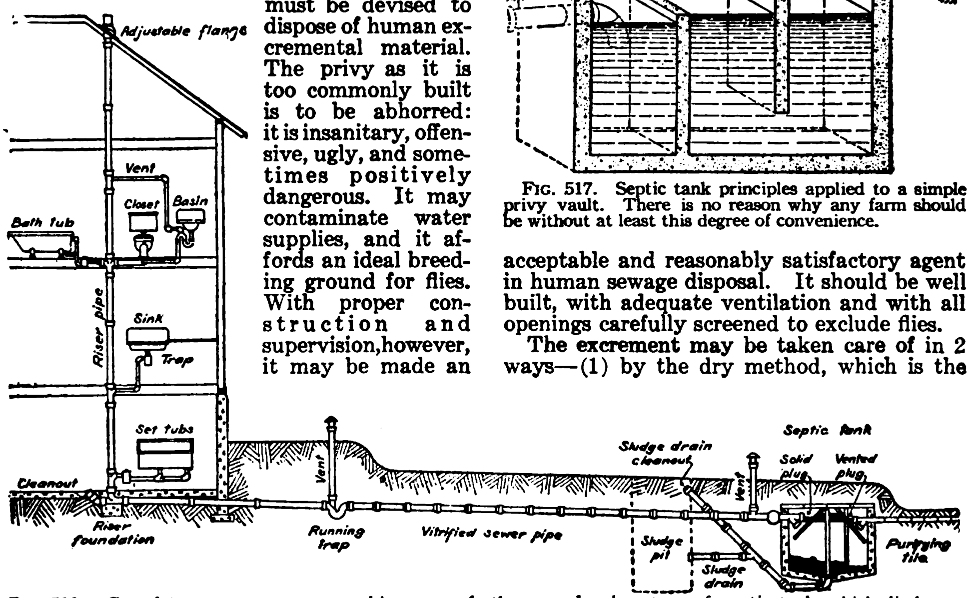



FIG. 516. Complete sewage system making use of the one-chamber type of septic tank which discharges into a line of purifying tile run under the garden or lawn

simpler, but requires constant attention, and (2) by the wet method which is more or less automatic and requires attention only at intervals. In the former a receptacle is provided which receives both the fecal matter and the urine; and each time the privy is used a small quantity of dry, fine earth or ashes or fresh-slaked lime is sprinkled over the deposit, to deodorize it. The receptacle must be watched and removed when necessary, the contents being buried in the soil at some place from which no harmful contamination can occur. Sometimes the receptacle is not entirely closed at the bottom, so that the urine may drain away, then to be carried to an underground system of loose tile, and absorbed into the soil.

The second method of equipping a sanitary privy with some means of liquid disposal may be carried out in one of several ways. The simplest is to place a rather large receptacle below the seat, the receptacle to be filled perhaps half full of water, which may or may not be supplied with some disinfecting agent; when necessary, the receptacle is removed and emptied in some safe place. A better but somewhat more elaborate method is to build a small water-tight chamber below the seat, in which septic action, to be described subsequently, may take place.

In construction, a sanitary privy should be, perhaps, 4 feet square, with tight walls, which may, if so desired, be built double to afford insulation from cold. The rear wall below the seat is provided with a hinged door, to facilitate the removal of containers; and the close and careful fitting of this door is important. Sometimes, such a privy is located adjacent to the house, and communication is made between the two by means of a vestibule, or, less to be recommended, directly through a door.

**Sewage disposal by bacterial action.** The most satisfactory method devised for sewage treatment makes use of bacterial action in accomplishing its reduction. Briefly, this action is as follows: Three kinds of bacteria operate in the disposal of sewage: aërobic bacteria which require the presence of oxygen for their existence; anaërobic bacteria which die in the presence of oxygen, and can work

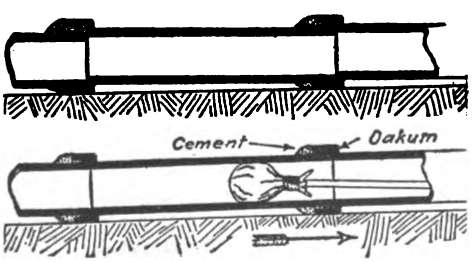



FIG. 518. Sewage tile laid incorrectly (*above*) and correctly (*below*). The interior course must be smooth and unbroken.

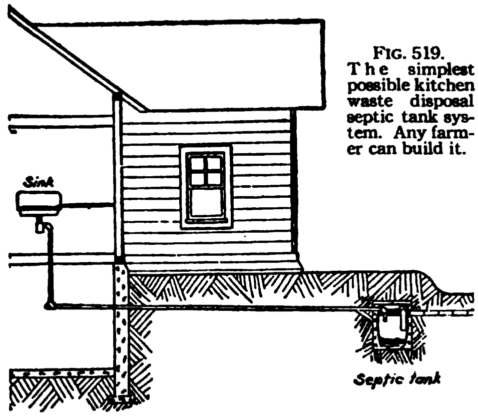



FIG. 519. The simplest possible kitchen waste disposal septic tank system. Any farmer can build it.

only where it is entirely excluded; and facultative bacteria, which live and operate under either of the above conditions.

When sewage is discharged into a retention chamber, it is first subjected to the action of the anaërobic bacteria; liquefaction to a certain degree occurs, the suspended organic matter breaking up into liquid and gaseous compounds with a slight precipitation of insoluble matter or sludge. The product of this decomposition is then carried out into the soil, which contains a certain amount of air and in which the aërobic bacteria can live and work. Here the sewage is purified by the oxidation of the decomposed compounds, rendering them usable as plant food. The facultative bacteria operate mainly in the first stage of the reduction.

**Cesspools.** The cesspool occupies a rather anomalous position in the field of sewage disposal. It usually consists of a simple pit loosely lined with brick or stone. Sewage is discharged into it directly, and it is evident that there will result an overlapping of reduction processes. Since the sewage will not be absorbed immediately, some anaërobic action is likely to occur, while that portion absorbed into the surrounding soil will be subjected to oxidation by aërobic bacteria. However, neither action will be even approximately complete.

The cesspool may operate with apparent success for an extended period; but sooner or later it will fail, owing to the soil surrounding it becoming water-logged and thus preventing aërobic action. Often, especially if the location of the cesspool be in very sandy, porous soil, it may operate well for years; but it is never safe, for the leachings from it are likely to be transmitted into strata from which the water supply is drawn. The cesspool is never to be recommended, except as a last resort.

**Septic tanks.** The septic tank is simply an elaborated cesspool in which provision is made for the proper accomplishment of the

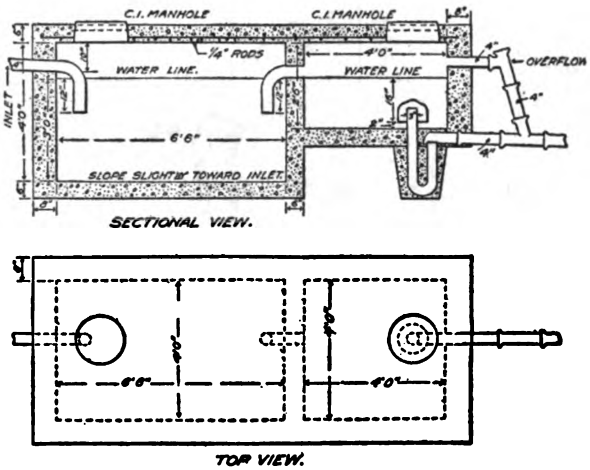



FIG. 520. Two-chamber septic tank with automatic siphon which periodically empties the smaller chamber. The liquid leaving such a tank is practically harmless.

bacterial reduction of sewage. In its most elementary form, it consists of a water-tight chamber of sufficient size to insure the retention of sewage for at least 48 hours, with a baffled inlet and outlet and a provision for the disposal of the effluent from this chamber. A better and more satisfactory form, and one which is more generally built, combines with the first chamber a second one in which is located an automatic siphon for the intermittent discharge of sewage, which prevents the soil from becoming water-logged. The decomposition of organic material is effected in the first chamber; the second stage, or oxidation, occurs in the subsurface distribution system into which the siphon discharges the liquefied sewage.

For an average family of 8 persons, the first chamber, or septic tank, should be 4 feet wide, 6½ feet long, and 4 feet deep. The second chamber should be 4 feet square, with a minimum depth of 2½ feet; and a 3-inch siphon should be used. The effective depth of sewage in the septic tank is only 3 feet, because of the inlet and outlet pipes; so that care must be taken that this is not materially diminished as a result of sludge accumulation.

Proper arrangement of the irrigation system to receive the effluent from the septic tank is necessary for successful operation. True, in some cases, the effluent is discharged upon the surface or in shallow trenches if the soil be porous; but this may ultimately prove undesirable. The subsurface method is much to be preferred. It consists of 3- or 4-inch ordinary agricultural tile, laid with open joints, at a depth of not exceeding 18 inches. The joints are protected by coverings consisting of pieces of broken tile, to prevent earth from falling in. In some especially close soils, it may be necessary to surround the tile with loose gravel, for the purpose of more rapid and complete absorption. The proportion of tile to the quantity of effluent discharged should be about 1 foot to 3 to 5 gallons of effluent, depending upon the character of the soil. It might be supposed, from the shallowness of the soil above the tile, that the effluent would freeze; but experience indicates the contrary.

A septic tank will not begin to operate satisfactorily until the septic chamber is filled; and even then it may be necessary to inoculate it with anaërobic bacterial cultures from another tank or cesspool, to correct the "sick" condition. A thick, heavy scum on the surface usually indicates good operation, and this should be disturbed as little as possible; the inlet and outlet should be protected by baffles, so that any discharges into or from the tank will not affect the scum. Often, a septic tank will operate well for years without any attention; but occasionally it may be necessary to remove sludge accumulations or to clean the siphon and discharge pipe.

It must be remembered that the reduction of sewage by this method may not be absolutely complete, nor is it certain that all disease germs will be destroyed; consequently, reasonable care should be given to the tank and to the subsurface system, in order that no harmful results may occur.

Creamery sewage. The disposal of wastes from a cheese factory or any milk-handling or dairy manufacturing establishment is one

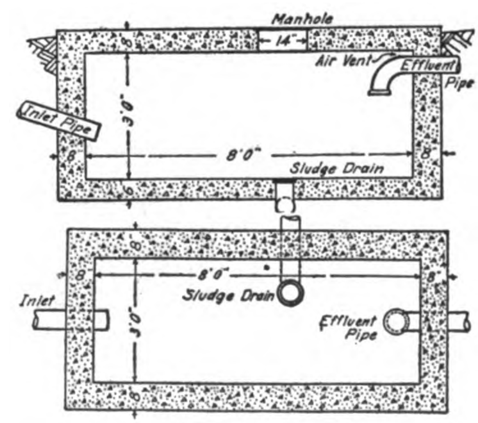



FIG. 521. Lengthwise section and plan of a single-chamber septic tank. If the discharge can be run out into a sandy or gravelly soil, it is entirely satisfactory, but in any case the accumulated sediment or sludge must occasionally be removed.

FIG. 522. Before (*left*) and after (*right*) the coming of modern plumbing and a sewage system to the average farm home. Inconvenience, endless daily chores and personal carelessness give way to greater comfort, less labor and better health and habits when such a change occurs

of the most vital factors in its installation. Quite often it is impossible to connect with a city sewer system, and no large stream of sufficient steady annual flow is available to afford adequate dilution; the ordinary household septic tank just described cannot adequately meet the demands for sewage disposal from a creamery or similar building.

Creamery sewage differs from ordinary sewage in that it contains curd, butter fat, oils, and considerable lactic acid, resulting from the cleansing of milk utensils and dairy product machines; and decomposition is somewhat slow. The tendency of lactic acid to retard or suppress bacterial action is so great that every effort should be made to reduce its quantity, and to exclude as much as possible from the septic tank.

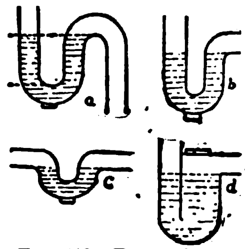



FIG. 412. Types of waste traps: *a* S-type; *b* half-S or P-type: *c* running trap: *d* drum or non-siphon type. In each case the object is to prevent the return of impure gases from the sewage system

It is recommended that creamery sewage be allowed to remain in the septic tank for a minimum of 3 days; a longer period being advisable, but necessitating a larger and consequently more expensive tank. Practice indicates that from 1 to 1½ gallons of sewage results from the production of 1 pound of butter, so that it is evident that, even in an ordinary small creamery of 1,000 pounds butter output, a much larger tank is necessary than for simple household requirements.

A sewage-disposal system for a creamery is constructed on practically the same principle as for any other purpose, the main variations occurring in the size of the tank and in the method of caring for the effluent from the septic tank proper. The ordinary subsurface irrigation system is usually inadequate, and a special filter bed of porous material may be provided. For a 1,000-pound capacity butter manufacturing plant, a septic tank of approximately 600 cubic feet content will be necessary; allowing for a 2-foot depth of scum and sludge, a tank 7 feet deep, 6 feet wide, and 20 feet long, is required. The filter bed should have an area of approximately 2 square feet per gallon of effluent, or about 3,000 square feet—say, 30 feet wide and 100 feet long.

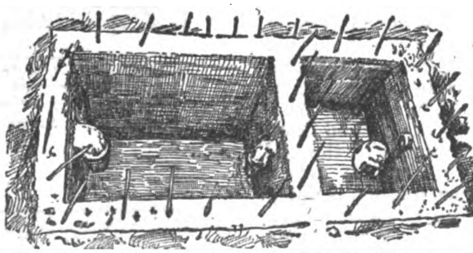


FIG. 514. Looking into a partly finished concrete, two-chamber septic tank. The iron rods will be bent over to help reinforce the concrete cover. Note in the right-hand chamber the siphon, which empties it as often as it becomes full, and thus gives the sewage the longest possible time to decay and purify under the action of bacteria

# CHAPTER 32

# Farm Buildings: Their Construction

*By* H. H. NIEMANN *(see Chapter 29), whose training and experience for a number of years have equipped him to design farm buildings, plan their location, arrangement and construction details, and superintend their erection from the basement to the weather vane. In discussing the farm group, he naturally included some consideration of that essential feature—the farm house. In this chapter he restricts himself to the discussion of farm work buildings, or rather the principles of construction that are common to all of them. The particular features and requirements of special types of houses planned for special purposes are treated in the chapters immediately following.*—EDITOR.

BEFORE one can decide what kind of materials are best for, or what particular type of construction to adopt in, the erection of a farm building, the requirements of the structure must first carefully be considered. Sometimes it is not practical to arrange and construct the contemplated building so as to fulfill all of these. In such cases the builder must be his own judge in making a selection.

## Requirements of Good Farm Buildings

**Keep contents of barn dry.** The first requirement of any farm building is that it shall keep out rain and dampness. Animals must be kept dry to keep them warm; foodstuffs must be kept dry to prevent mold; and tools and implements must be kept dry to prevent rusting.

Keeping the animals warm and dry will save a considerable portion of their energy. Keeping mold, mildew, and fermentation out of grain, hay, feed, and other crops by storing them in a dry barn is very important. Rust and corrosion in implements, tools, and vehicles can be most economically prevented by keeping them in a dry building.

**Pure air, proper temperature, and good light essential.** Pure air is as essential as food for the well-being of animals. In fact, all animals require more pounds of air per day than they do of food and water combined.

Air once breathed is not only full of poison, but is saturated with moisture. Unless proper ventilation is provided, this moisture will soon increase the humidity of the air in a barn to such an extent that water will drop from the ceiling and run down the side walls.

In a warmly built barn, a smaller amount of the food consumed by the livestock is used to produce heat, and a greater amount for the production of meat or milk, tending to convert the boarder cow into a profitable producer.

In order to keep milk cool, or to preserve ice, the dairy or the icehouse must be built to resist changes in temperature.

The necessity of light is very much neglected, even in many of our so-called up-to-date barns. We all know that unrestricted sunlight is nature's greatest destroyer of bacterial life, that it is essential for the healthy development of all

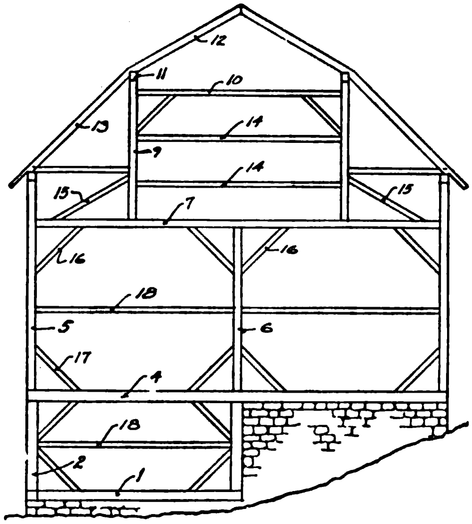



FIG. 525. Bank barn showing end framing of the heavy timber type. Though common in the early days this is now practically never employed because of the difficulty of getting heavy material. (See page 375 for names and sizes of parts designated here by numbers).

livestock, and that it is also the cheapest disinfectant obtainable. Knowing this is it not "penny wise and pound foolish" to bar out sunshine because glass costs a few cents more per square foot than lumber?

**Cleanliness and comfort for the animals.** The most effective aid in keeping the barn clean is to so build and equip it that the labor and time required for cleaning will be reduced to the minimum. In its construction, avoid all unnecessary angles, corners, cracks, and crevices. Use materials that will produce smooth surfaces and be as far as possible impervious to moisture. The equipment for cleaning and for the removal of litter should be sufficient and effective.

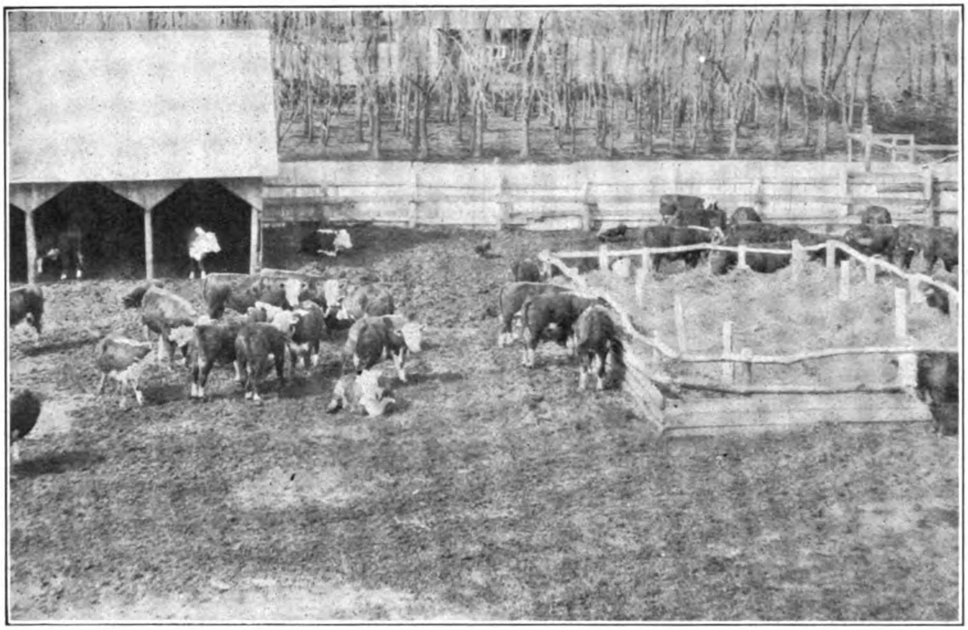
Cleanliness is the one paramount requirement, where articles of human food are concerned. There is no excuse for the unsanitary dairy or for the disease-laden and rat-infected buildings often used to shelter poultry and other livestock.

Prevent the waste of grain and the spread of disease by making the barn and all other farm buildings proof against rats, mice, and other vermin. Use masonry construction with plenty of cement below ground and as far above ground as its cost will permit. All hollow-masonry work, such as tile or cement block, should occasionally have one layer filled solid with cement mortar, or a layer of slate or shingle tile should be inserted in the courses, so that no air space in walls or floors will form a continuous passage for mice.

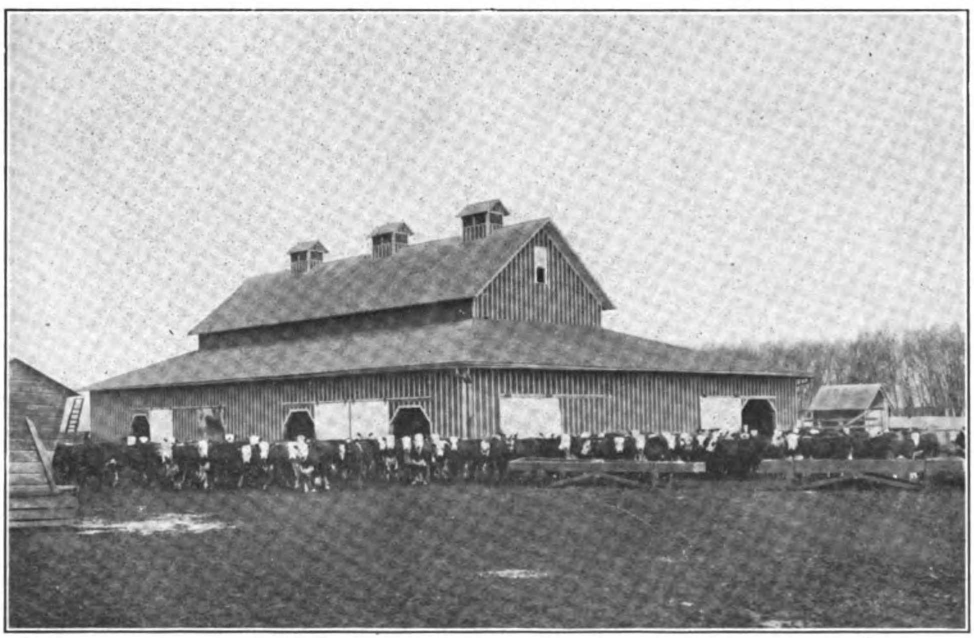
Provide all stalls with simple and sanitary ties or stanchions which will allow the animal to make freely any of its natural motions, protect itself against insects and other enemies, and to be comfortable either standing or lying down. Make provisions in the barn for supplying the animals with an abundance of fresh, clean water at all times.

Stalls should be so grouped that bedding may be conveniently supplied both for comfort and for the absorption of liquids. Stall gutters with ample slope should be provided, with sanitary trap and strainer of a type easily removable for cleaning, or for flushing tile which leads to the manure cistern, with which every barn should be provided.

**Economy in feeding and watering.** Economy in feeding and watering is of great importance. It includes not only saving of feed and water, but saving of the labor of feeding also. Arrange feed storage and mixing space convenient to the feeding alley. The greatest economy in feeding is secured by having the stock arranged in 2 rows of stalls, all facing the feed alley running lengthwise between the rows. A feed room with bins on the sides or above, with hopper bottoms and spouts, located at one end of the feed alley, large enough for sheller, fanning mill, grinder, and mixing bins, and having good outside light, dustproof doors to feeding alley, and entrance doors from the outside is most convenient. It is also advisable to have silo and hay chutes in the feed room rather than direct in the feeding alley, in order to avoid dust in the stable.



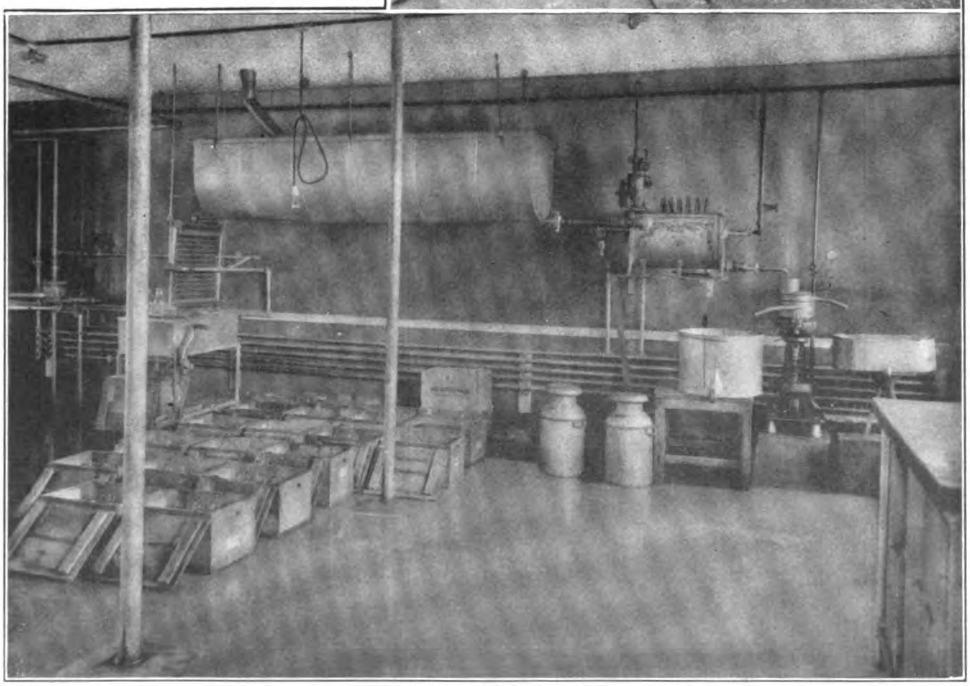
This combination of an open shed facing south, a tight fence around the feed lot and a windbreak beyond, insures comfort for the animals and rapid profitable gains



A feeding barn for fattening beef cattle, in which hay is stored in the centre; the feeding racks and bunks are located under cover, around it

COMFORTABLE, CONTENTED ANIMALS DO THE BEST WORK, GIVE THE MOST MILK, MAKE THE QUICKEST GAINS AND RETURN THE LARGEST PROFITS. THE BUILDINGS LARGELY DETERMINE THE DEGREE OF THEIR COMFORT AND CONTENTMENT

Under some conditions butter making for market does not pay. This is one such condition



Inside the creamery on a practical Massachusetts dairy farm, which has enabled it to secure and hold a high-class, profitable city milk and cream trade

MANUFACTURING WORK ON THE FARM AS ELSEWHERE, IF IT IS TO BE PROFITABLE, MUST BE PLACED ON A BASIS OF SCIENTIFIC EFFICIENCY

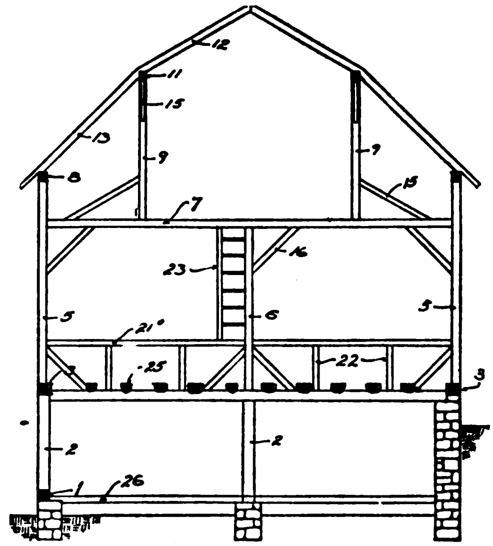



FIG. 526. An intermediate type of barn framing. The basement would be improved by including a bridged space between wall and bank as shown in Fig. 583*b*.

Labor-saving devices and conveniently arranged farm buildings mean the elimination of much irksome farm work, and, consequently, the shortening of working hours.

Construct hay-storage rooms and implement rooms as free of posts and other obstructions as economical and durable construction will admit.

Economy of space often involves a saving in expense and in the convenience of using it. Concentrate all feeds so that their distribution will be central in relation to all stalls. Arrange all the tie stalls nearest the feed room and all pens and box stalls farthest away from the feed rooms so that the largest bulk of feed will be carried the shortest distance.

Arrange cleaning alleys with doors convenient to the manure pit. Arrange tool room so that a definite place may be assigned to each tool and implement, and that any tool may be taken out or replaced without disturbing other tools or implements.

**Economy in construction.** To secure economy in construction use local materials, so far as the requirements of the building will permit. If the farm contains a bank of good building sand, all foundation work and most of the lower-story walls can be built as cheaply of concrete as lumber purchased at retail prices. Should the farm contain field stone, it may be used with economy in the walls and foundation of any kind of farm building. Where no sand, gravel, or stone is convenient, brick or hollow tile may be most economical. Most of the local woods which grow in the woodlot may be used with economy and satisfaction for all farm buildings.

For average conditions, a plank frame superstructure is more economical than one built of heavy square timbers.

The roofing question is an important one, hinging, to a large extent, on local markets. It is advisable to procure quotations on several good roofing materials available in the locality, before a decision is made.

While economy in construction is desirable because it keeps down the original cost of a building, strength and durability are also desirable because they insure permanence and low expense for upkeep. Quite often it is possible to procure a suitable material which combines economy with strength and durability. Time is always well spent in investigating local market conditions before deciding definitely what material is the most efficient. To build for permanence may not add greatly to the original cost; and the saving in upkeep, insurance, and depreciation will soon make the permanent building the cheapest.

**Protection against fire.** Fire causes most of the building losses on farms, and has destroyed in the United States in a year buildings worth nearly half as much as the new ones erected in the same period. Fire insurance may repay the farmer the worth of the burned portions of a building; but it does not make up for the total loss incurred by the exposure of livestock to storms, nor for other inconveniences and expenses incurred during the rebuilding or restoration of the damaged premises.

Use fire-resisting materials, such as stone, brick, concrete, or tile as much as possible. If wood construction is used for the superstructure, place the buildings a safe distance apart—100 feet or more is advisable. When, for the sake of convenience, or from lack of space, or owing to climatic conditions, it is necessary to connect the buildings, build fire walls with fire-resisting doors between all buildings.

**Design should be pleasing and logical.** A pleasing appearance is by no means a minor consideration, and it can be obtained without additional expense. Beautiful landscapes defiled by unsightly structures should be a thing of the past. Substantial, sightly buildings give the farm an appearance of prosperity.

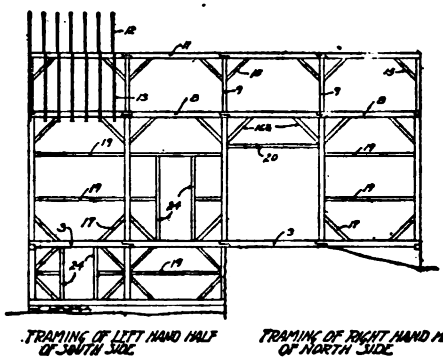


FIG. 27 Other details of the heavy timber type of barn framing

The tendency to follow the design of existing buildings in a neighborhood is no doubt the greatest hindrance to progress in barn construction. Defects are perpetuated and improvements ignored in copying the arrangement and construction of old barns, even if these have been found handy and durable. Farming methods are changing rapidly, and the old type of barn will soon be classed among relics.

Each building should be carefully planned for the service it is to render, regardless of previous practice. Time and effort expended in analyzing the needs of this service and in planning to meet these needs in the best possible manner will save labor and expense as long as the building is used. Compact arrangements pay dividends by saving labor.

## Building Materials and Their Proper Use in Construction

It may be well said that in the construction of farm buildings there is a proper place for all building materials and that each material should be applied in its proper place. No building material meets all of the requirements mentioned in the preceding paragraphs, but the one best suited to its particular purpose should be selected from the many available. Below are given certain rules and standards with which the various materials must comply in order to meet the building requirements, together with suggestions as to how the materials should be applied and what materials may be used with the best results.

**Excavations for buildings.** The ground must be excavated before putting in foundations, either for basement or for trenches, to place the masonry below the frost line. The nature of the ground must be carefully noted, after excavations have been carried down to a depth where no frost will occur under the walls; the kind of subsoil will determine the width of the footing or lower course of stone or concrete upon which the weight of the building will rest. For building purposes, the various kinds of soil may be classified as follows: bed rock, clay, gravel, and sand.

Bed rock is generally safe to build on for any kind of structure, provided the foundation beds are kept level.

Gravel, even when mixed with small boulders, may also be considered perfectly reliable for any ordinary structure.

Sand will carry very heavy loads, provided it is confined; but great precautions must be taken to confine it properly, and also to keep running water from it, as the action of the latter will soon wash it away.

Clay, when compact and dry, will carry large loads, but water should be kept from it, both under and around the structure, because wet clay is pasty and semiliquid, causing the foundation to slip and settle unequally.

Clayey soils should be thoroughly tiled inside and outside of the foundation footing, and gravel or cinders used for filling in above the tile and against the foundation.

The silt, slush, and decayed vegetation of the marshy lands in the southern states require spread footings.

In all cases, the base of the foundations should be so spread out as to keep the pressure per square foot of footings within the safe limit. The accompanying table gives the safe bearing power of soils, and may be used by calculating the weight of the building and its contents and spreading the foundations to cover the required area for its safe load.

BEARING POWER OF SOILS IN TONS PER SQUARE FOOT

| KIND OF MATERIAL | MINIMUM | MAXIMUM |
|---|---|---|
| Rock, equal to stone masonry | 25.25 | 40 |
| Clay, dry, in thick beds | 4 | 6 |
| Clay, soft | 1 | 2 |
| Gravel or coarse sand, well cemented | 8 | 10 |
| Sand, compact and well cemented | 4 | 6 |
| Sand, clean and dry | 2 | 4 |
| Quicksand, alluvial soils, etc. | 0.5 | 1 |

**Foundation footings and walls.** By spreading the load of the structure over a larger area of bearing surface, the weight of the building is more evenly distributed. Timber is sometimes used for spread footings where a large bearing surface is necessary; this is perfectly sound construction, if the ground is continually wet, because timber will not decay when kept saturated with water.

The best method of using plank under a masonry wall is to use 4 x 12 inch plank, cut to short, uniform lengths and placed crosswise in the trench so that the grain of the wood runs at right angles with the length of the wall. The masonry wall should be placed in the centre so that the planking will project equally beyond both faces of the wall.

Good concrete is unquestionably the best material for footings, even if stone or brick is used for the foundation walls. It is continuous, without joints, and has the advantage of arching itself over any soft places in the soil that would allow other materials to settle, cracking the walls. Concrete footings are generally made by excavating the bottom of the wall trench to the exact width required for the concrete and with a true, level bottom, so that the concrete may be poured directly into the trench without the use of forms.

Foundation walls are mostly built out of

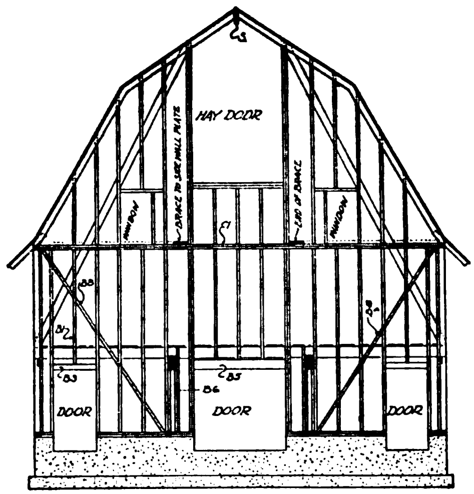



FIG. 528. End framing of a 36-foot wide barn built on the braced-rafter type. This design makes the use of a hay hoisting rig and track (S) practically essential.

stone, concrete, brick, or tile. Either of these may be used, provided it is of first-class material, for any kind of foundation; and the selection may be made by comparing their cost in the locality.

## Materials Used in Masonry Construction

All walls, whether of brick, tile, or stone, should be laid in cement mortar, or lime-cement mortar mixed in the proportions hereafter given.

**Lime.** Lime is the product of the burning of limestone. Both cement and lime should be kept in a dry place, as exposure to the air causes lime to air-slake and cement to "take a set" and become useless.

**Cement.** Portland cements are composed of pure clay and pure lime combined in certain definite proportions, thoroughly mixed, and calcined, then ground to a fine powder, and packed in sacks. These cements will stand 4 parts of sand to 1 of cement, for cement mortar.

**Sand.** The sand used in making mortar should have no mixture of clay or loam in it, but should be clean and sharp particles of quartz or other disintegrated rock. These particles enter readily into the irregularities of the surfaces of stone or brick, thus forming a perfect bond.

**Lime mortar.** For lime mortar, the lime should be slaked by pouring water on it. The water is very quickly absorbed by the lime in the process of slaking; care should be taken to keep all the pieces wet by adding water as fast as the lime will take it up.

Lime mortar is prepared in much the same

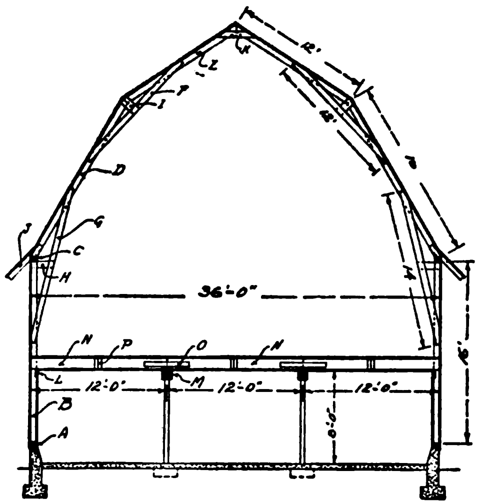



FIG. 529. Section of the barn shown in Fig. 528, showing the abundant mow space and absence of interfering supports, rafters, etc.

way as pure cement mortar. For mixing lime mortar, a bed of sand is first made in the mortar box, and the lime is distributed as evenly as possible over it, both the lime and the sand being first measured, in order that the proper proportions may be obtained. The proportion of sand and lime usually specified is 3 of sand to 1 of lime.

It is considered better to make lime in large quantities; then to leave it in piles for use as it may be needed, after stirring and tempering.

**Cement-and-lime mortar.** For this mortar the lime should be first slaked and then allowed to stand until it is thoroughly cool. Mix the cement and sand together dry, using 1 measure of cement to 4 measures of sand; to this add the slaked lime, mix thoroughly, and reduce with water to the proper consistency. Cement-and-lime mortar should be used as soon as mixed, before the cement sets.

**Cement mortar.** This should be mixed in the proportion of from 3 to 4 parts sand to 1 of cement. It is advisable that these parts be actually measured, so that there will be no question about having the proportions just right. After the sand and cement are thrown on the platform, they must be thoroughly mixed by shoveling the two materials together, at least twice, so that the cement may be thoroughly incorporated with the sand. Sufficient water should now be added to make a stiff paste, and the mortar must be immediately conveyed to the work and used, as the cement sets very rapidly and, after it is once hard, the mortar cannot be used again.

**Brick.** Brick may be called an artificial stone, manufactured in small pieces for convenience in laying. The principal ingredients in brick are clay and protoxide of iron. In the eastern states, most of the common brick are made $7\frac{3}{4}$ x $3\frac{3}{4}$ x $2\frac{1}{4}$ inches; in the western states the common brick are made $8\frac{1}{4}$ x $4\frac{1}{8}$ x $2\frac{1}{4}$ inches.

Good building brick should be well burned and quite hard. It should have a ringing sound when two bricks are struck together. A good brick should not absorb more than one tenth its weight in water, nor should it break under a crushing load of less than 4,000 pounds per square inch.

**Brick masonry.** No brick walls, even for the smallest buildings, should be built less than 8 inches in thickness. Eight-inch walls should never be more than 10 feet, nor more than one story in height. All walls that are subject to lateral pressure from movable materials piled against them, from heavy wind pressure or from the outward thrust of roof rafters, should never be less than 12 inches in thickness. No 12-inch walls should be more than 22 feet in height or more than 2 stories high.

Walls for 1-story buildings having many windows, such as dairy barns, should have either 12-inch walls or 8-inch walls reinforced at intervals with pilasters. These pilasters may be built hollow and, in the case of livestock barns, may be used for ventilation flues. Where pilasters are to support concentrated loads from the ends of girders, roof-trusses, etc., they should be built solid and with cement mortar.

**Brick laying.** All brickwork must have a good bed of mortar between all bricks. Brickwork, therefore, consists of both brick and mortar. The strength of any piece of brickwork depends on the quality of the brick, the strength and quality of the mortar, the way in which the bricks are laid and bonded, and whether or not the bricks are laid wet or dry.

Brick should be laid in a bed of mortar at least three sixteenths and not more than three eighths of an inch in thickness. Every vertical joint between ends of brick and all spaces between the outer and inner courses of brick must be filled in solid with mortar, so that no air space will exist within the walls.

**Stone masonry.** If rubble stone can be procured on the farm or near by, it will no doubt make the most economical wall; and it may be used from the footing up to the window-sill level in barns where a large number of windows are necessary. In many cases, too, it may be carried up to the hay-mow floor level or to the roof.

It does not pay to carry the stonework up between the windows where they are spaced close together, because the amount of labor required in dressing the stone to square corners will cost more than other and more appropriate materials.

The most satisfactory manner of measuring stonework is by the cubic foot or cubic yard.

The cord (128 cubic feet) is sometimes used. The perch is a measure that is often misleading, because its value ranges all the way from 16 to 24 cubic feet, according to local custom.

It requires about one third cubic yard of mortar to lay up 1 cubic yard of rubble-stone work. This amount of cement mortar will require about two thirds of a barrel of cement and three tenths of a cubic yard of sand.

The safe bearing load on rubble-stone masonry is calculated at 80 pounds per square inch, if lime mortar is used, and 150 pounds if cement mortar is used.

A wall can be built very economically of field stone or boulders by proceeding as in laying concrete. Set in the plank forms to the thickness of the walls, fill in with cement mortar about 3 inches deep, then place the stones in this mortar, packing them as close together as possible, and placing the smaller stones between the larger ones. After a layer of stone has been placed in the form, put in more mortar, covering the stone over with mortar several inches deep, and then proceed with another layer of stone as before. This can be done by unskilled labor and the work will progress very rapidly. One side of the form is built up the full height of the wall to start with; and the side from which the stone is laid is built up one plank at a time as the wall is laid, so that there will be no unnecessary lifting of materials.

Concrete masonry. In estimating the amount of material required for barn or basement walls, the accompanying table compiled by a well-known cement company gives information for 3 heights of concrete walls. The proportions of the ingredients are 1 part of cement to 2½ of sand and 5 of stone or gravel.

| DIMENSIONS OF WALL | | | MATERIAL PER 10 RUNNING FT. | | |
|---|---|---|---|---|---|
| Height Feet | THICKNESS Bottom Inches | THICKNESS Top Inches | Cement Sacks | Sand Cu. Ft. | Gravel Cu. Ft. |
| 6 | 6 | 6 | 6 | 14½ | 29 |
| 8 | 10 | 8 | 12 | 29 | 58 |
| 10 | 15 | 10 | 24 | 57 | 114 |

The materials required for 1 cubic yard of concrete of various mixtures may be found by the following table, published by another cement company:

| MIXTURES | | | QUANTITIES OF MATERIALS | | |
|---|---|---|---|---|---|
| Cement | Sand | Gravel | Sacks of Cement | Cubic Yards of Sand | Cubic Yards of Gravel |
| 1 | 2 | 3 | 7.0 | .52 | .78 |
| 1 | 2 | 4 | 6.0 | .44 | .89 |
| 1 | 2.5 | 4 | 5.6 | .52 | .83 |
| 1 | 3 | 5 | 4.6 | .51 | .85 |

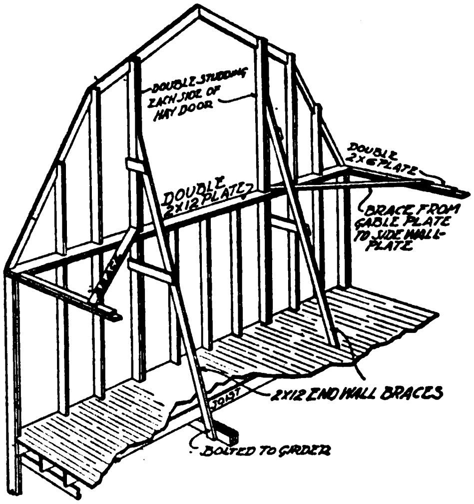



FIG. 530. Detail of end of barn built on the braced rafter plan, showing how to brace the gable end walls to resist the hay pressure (see p. 377).

Concrete, when properly handled, is recognized by the farmer as satisfactory material for all forms of building work. The advantages of good concrete are: protection against fire and decay; absence of repairs; saving of insurance; practical indestructibility; cleanliness; and vermin proofness—all resulting in the greatest economy. Good concrete is water-tight; walls built of it are light in color, reflecting light to all parts; and it leaves no small corners, crevices, or pockets in which dirt may collect.

The use of concrete by farmers has increased enormously, but it has been pretty largely restricted to the building of floors, walks, foundations, and retaining walls. The reason for this is that it has been necessary to erect wooden forms, making heavy, cumbersome work at great expense. To-day, adjustable steel forms, that can be used for any type of solid or double wall, may be purchased at such a low price that concrete walls can, in most places, be built for about the price they would cost if built of wood.

The double-wall construction, with a continuous air space for insulation against temperature and dampness, meets all the requirements for any type of farm building.

Small 1-story farm buildings may be built strictly fireproof by making the roof of concrete on stiffened, expanded metal. The latter can be purchased in lengths up to 12 feet. The expanded metal is supported by the walls and on steel or reinforced concrete beams between the walls at intervals of 6 to 10 feet. Concrete is spread on top of this expanded metal to a thickness of about 2 inches and, when hard, the underside is also

plastered with concrete, so that the metal is entirely imbedded in the slab. When thoroughly set, this slab becomes very strong; and the top surface is then coated with asphalt or some other elastic roofing paint to make it thoroughly waterproof. This method of roof construction is very economical, is stormproof, waterproof, and indestructible.

## Carpentry

The rules which govern the grading of the various kinds of lumber sold on the market are determined by the various lumber associations. These associations publish small pamphlets containing the grading rules, which may be obtained free upon request. For additional information regarding the properties of lumber, application should be made to the United States Department of Agriculture, Forest Service, Washington, D. C.

**Standard sizes of dressed lumber.** Finishing lumber is dressed to the following: 1 inch S. 1 S. or 2 S. to 13/16; 1¼ inches S. 1 S. or 2 S. to 1 1/16; 1½ inches S. 1 S. or 2 S. to 1 5/16; 2 inches S. 1 S. or 2 S. to 1¾ inches. 1 x 4 S. 4 S. is 3½ inches wide finished; 1 x 5 S. 4 S. is 4½ inches wide; 1 x 6 is 5½ inches; 1 x 7 is 6½ inches; 1 x 8 is 7½ inches; 1 x 9 is 8½ inches; 1 x 10 is 9½ inches; 1 x 11 is 10½ inches, and 1 x 12 is 11¼ inches.

**Flooring.** The standard of 1 x 3, 1 x 4, and 1 x 6 inches D. and better is worked to 13/16 x 2¼, 3¼, and 5¼ inches; 1¼-inch flooring is 1 1/32 inches thick; 1½-inch flooring is 1 11/32 inches thick, the same width and matching as 1-inch stock.

**Drop siding.** D. and M. is worked to ¾ x 3¼ and 5¼ inches face, 4½ and 5½ over all. Worked ship-lap, ¾ x 5 inches face, 5½ over all.

**Ceiling.** Ceiling is worked to the following: ⅜-inch ceiling, 5/16 inch; ½-inch ceiling, 7/16 inch; ⅝-inch ceiling, 9/16 inch; ¾-inch ceiling, 11/16 inch. Same width as flooring. Working of ceiling is beaded centre and edge with slight bevel on groove edge. The bead on all ceiling and partition is depressed 1/32 inch below surface line of piece.

**Bevel siding.** This is made from stock S. 4 S. worked to 13/16 x 3½ and 5½, and resawed on a bevel.

**Ship-lap and barn siding No. 1 common.** 8, 10, and 12 inches is worked to 13/16 x 7⅛, 9⅛, and 11⅛ inches.

**D. and M. No. 1 Common.** 8, 10, and 12 inches is worked to 13/16 x 7⅛, 9⅛, and 11⅛ inches.

**Grooved roofing.** 10 and 12 inches S. 1. S. and 2 E. is worked to 13/16 x 9½ and 11¼.

Dimensions are worked to the actual sizes shown in the accompanying table:

### ACTUAL SIZES OF LUMBER DIMENSIONS, IN INCHES

(SOUTHERN YELLOW PINE MANUFACTURERS' ASSOCIATION)

FOR SURFACED ONE SIDE AND ONE END

| BREADTH<br>DEPTH | 2 INCHES | 4 INCHES | 6 INCHES | 8 INCHES | 10 INCHES |
|---|---|---|---|---|---|
| 4 inches | 1⅝ x 3⅝ | 3⅝ x 3⅝ | | | |
| 6 inches | 1⅝ x 5⅝ | 3⅝ x 5⅝ | 5⅝ x 5⅝ | | |
| 8 inches | 1⅝ x 7½ | 3⅝ x 7⅝ | 5¾ x 7¾ | 7¾ x 7¾ | |
| 10 inches | 1⅝ x 9½ | 3⅝ x 9⅝ | 5¾ x 9¾ | 7¾ x 9¾ | 9¾ x 9¾ |
| 12 inches | 1⅝ x 11½ | 3⅝ x 11⅝ | 5¾ x 11¾ | 7¾ x 11¾ | 9¾ x 11¾ |

FOR SURFACED FOUR SIDES

| | | | | | |
|---|---|---|---|---|---|
| 4 inches | 1½ x 3½ | 3½ x 3½ | | | |
| 6 inches | 1½ x 5½ | 3½ x 5½ | 5½ x 5½ | | |
| 8 inches | 1½ x 7⅜ | 3½ x 7½ | 5½ x 7½ | 7½ x 7½ | |
| 10 inches | 1½ x 9⅜ | 3½ x 9½ | 5½ x 9½ | 7½ x 9½ | 9½ x 9½ |
| 12 inches | 1½ x 11¾ | 3½ x 11½ | 5½ x 11½ | 7½ x 11½ | 9½ x 11½ |

## BOARD FEET OF LUMBER IN TIMBERS OF VARIOUS SIZES

| SIZE IN INCHES | LENGTH IN FEET | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 |
| 2 x 4 | 6⅔ | 8 | 9⅓ | 10⅔ | 12 | 13⅓ | 14⅔ | 16 | 17⅓ |
| 2 x 6 | 10 | 12 | 14 | 16 | 18 | 20 | 22 | 24 | 26 |
| 2 x 8 | 13⅓ | 16 | 18⅔ | 21⅓ | 24 | 26⅔ | 29⅓ | 32 | 34⅔ |
| 2 x 10 | 16⅔ | 20 | 23⅓ | 26⅔ | 30 | 33⅓ | 36⅔ | 40 | 43⅓ |
| 2 x 12 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 |
| 2 x 14 | 23⅓ | 28 | 32⅔ | 37⅓ | 42 | 46⅔ | 51⅓ | 56 | 60⅔ |
| 4 x 4 | 13⅓ | 16 | 18⅔ | 21⅓ | 24 | 26⅔ | 29⅓ | 32 | 34⅔ |
| 4 x 6 | 20 | 24 | 28 | 32 | 36 | 40 | 44 | 48 | 52 |
| 4 x 8 | 26⅔ | 32 | 37⅓ | 42⅔ | 48 | 53⅓ | 58⅔ | 64 | 69⅓ |
| 4 x 10 | 33⅓ | 40 | 46⅔ | 53⅓ | 60 | 66⅔ | 73⅓ | 80 | 86⅔ |
| 6 x 6 | 30 | 36 | 42 | 48 | 54 | 60 | 66 | 72 | 78 |
| 6 x 8 | 40 | 48 | 56 | 64 | 72 | 80 | 88 | 96 | 104 |
| 6 x 10 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 |
| 6 x 12 | 60 | 72 | 84 | 96 | 108 | 120 | 132 | 144 | 156 |
| 6 x 16 | 80 | 96 | 112 | 128 | 144 | 160 | 176 | 192 | 208 |
| 8 x 8 | 53⅓ | 64 | 74⅔ | 85⅓ | 96 | 106⅔ | 117⅓ | 128 | 138⅔ |
| 8 x 10 | 66⅔ | 80 | 93⅓ | 106⅔ | 120 | 133⅓ | 146⅔ | 160 | 173⅓ |
| 8 x 12 | 80 | 96 | 112 | 128 | 144 | 160 | 176 | 192 | 208 |
| 10 x 10 | 83⅓ | 100 | 116⅔ | 133⅓ | 150 | 166⅔ | 183⅓ | 200 | 216⅔ |
| 10 x 12 | 100 | 120 | 140 | 160 | 180 | 200 | 220 | 240 | 260 |
| 12 x 12 | 120 | 144 | 168 | 192 | 216 | 240 | 264 | 288 | 312 |
| 12 x 14 | 140 | 168 | 196 | 224 | 252 | 280 | 308 | 336 | 364 |

**Heavy flooring.** For 2 and 2½ inches, matching, the thickness should be ⅜ inch less than the rough material. The tongue should be ⅜ inch thick and ⅜ inch long. For 3-inch and thicker matching, the tongue should be ¾ inch thick and ⅜ inch long, and the thickness of the stock should be ⅜ inch less than the rough material.

**Heavy ship-lap.** This is worked to the same thickness as heavy flooring. The lap is ½ inch long, occupying one-half the finished thickness of the piece.

**Timbers.** These are worked to the following: 4 x 4 and larger S. 1. S. or S. & E., ⅜ inch off each face surfaced; S. 3 S. or S. 4 S., ¼ inch off each face surfaced.

**Plastering lath.** No. 1 measure 2 inches in thickness to every 5 lath, green; the minimum thickness of any one lath is not less than $\frac{5}{16}$ inch green, and is not less than $1\frac{7}{16}$ inches in width, green, length 4 feet, 1⅝ inches thickness to every 5 lath, dry, and do not measure less than $1\frac{5}{16}$ inches in width, dry. They are not more than ½ inch scant in length when dry.

To determine the number of board feet in timber, it should be remembered that a board foot is the measure of a piece of timber 12 inches long, 12 inches wide, and 1 inch thick. Thus a block of timber 12 inches square on the end, and 1 foot long, would contain 12 board feet.

**Shrinkage of timber.** Timber shrinks but very little lengthwise of the grain when drying, but crosswise the shrinkage may be quite considerable. The soft woods, such as pine, spruce, or cypress, shrink evenly, with but little cracking; but the hard woods, such as oak and hickory, are often subject to injury in shrinking.

### APPROXIMATE SHRINKAGE OF TIMBER PER FOOT OF WIDTH IN DRYING

| KIND OF WOOD | SHRINKAGE | KIND OF WOOD | SHRINKAGE |
|---|---|---|---|
| Ash | .60 | Horse chestnut | .72 |
| Basswood | .72 | Locust | .72 |
| Beech | .60 | Maple | .60 |
| Birch | .72 | Oak | 1.20 |
| Box elder | .48 | Pine, hard | .48 |
| Cedar | .36 | Pine, soft | .36 |
| Cherry | .60 | Poplar | .60 |
| Chestnut | .72 | Spruce | .36 |
| Cypress | .36 | Sycamore | .60 |
| Elm | .60 | Tamarack | .48 |
| Hickory | 1.20 | Walnut | .60 |
| Honey Locust | .48 | | |

**Ordinary lumber waste.** In the use of ordinary lumber on walls, floors and ceilings, the following percentages should be added to the actual measurement of the surface to be covered, in order to allow for lapping, matching, etc.:

Battens, 1 x 4, placed 6 inches on centres, only ⅔ of surface measure is needed.

Battens, 1 x 6, placed 8 inches on centres, only ¾ of surface measure is needed.

Ceiling will be same as flooring (see below).

| | PER CENT |
|---|---|
| Flooring, 3-inch matched . . . . . | 50 |
| Flooring, 4-inch. . . . . . . . . | 33 |
| Flooring, 6-inch. . . . . . . . . | 20 |

Papers and felts are usually listed sufficiently below the actual contents of the roll to allow for lapping.

| | PER CENT |
|---|---|
| Sheathing, common, laid horizontally on walls without openings | 10 |
| Sheathing, common, laid horizontally on roofs without openings | 10 |
| Sheathing, common, laid diagonally on buildings with usual openings | 17 |
| Sheathing, tight, 6 inches, laid horizontally | 20 |
| Sheathing, tight, 8 inches, laid horizontally | 15 |
| Sheathing, tight, 10 inches laid horizontally | 12 |
| Sheathing, tight, 6 inches, laid diagonally | 25 |
| Sheathing, tight, 8 inches, laid diagonally | 17 |
| Sheathing, tight, 10 inches, laid diagonally | 12 |
| Siding, drop | 20 |
| Siding, lap, 4 inches to weather | 50 |
| Siding, lap, 4½ inches to weather | 33 |

To estimate the quantity of sheathing or of ship-lap, approximately, calculate the exact surface to be covered, deducting openings; then add the following percentages:

| | SHEATHING PER CENT | SHIP-LAP PER CENT |
|---|---|---|
| For floors | 1/7 or 15 | 1/6 or 17 |
| For side walls | 1/6 or 17 | 1/5 or 20 |
| For roofs | 1/5 or 20 | 1/4 or 25 |

## WEIGHT OF WIRE NAILS NEEDED PER 1,000 FEET OF LUMBER

| KIND OF MATERIAL | DISTANCE APART OF JOIST, OR STUDDING NAILING SPACE, IN INCHES | NUMBER OF NAILS TO EACH BOARD, EACH NAILING SPACE | SIZE OF NAIL | POUNDS OF NAILS |
|---|---|---|---|---|
| Framing 1 x 4 | 16 | 2 | 10d. common | 65 |
| " 1 x 4 | 24 | 2 | 10d. " | 45 |
| " 1 x 6 | 16 | 2 | 10d. " | 43 |
| " 1 x 6 | 24 | 2 | 10d. " | 30 |
| " 1 x 8 | 16 | 2 | 10d. " | 32 |
| " 1 x 8 | 24 | 2 | 10d. " | 23 |
| " 1 x 10 | 16 | 3 | 10d. " | 39 |
| " 1 x 10 | 24 | 3 | 10d. " | 27 |
| " 1 x 12 | 16 | 3 | 10d. " | 32 |
| " 1 x 12 | 24 | 3 | 10d. " | 23 |
| " 2 x 6 | 24 | 2 | 30d. " | 53 |
| " 2 x 8 | 24 | 2 | 30d. " | 40 |
| " 2 x 10 | 24 | 3 | 30d. " | 48 |
| " 2 x 12 | 24 | 3 | 30d. " | 40 |
| Ship-lap 1 x 8 | 16 | 2 | 10d. " | 36 |
| " 1 x 8 | 24 | 2 | 10d. " | 26 |
| " 1 x 10 | 16 | 3 | 10d. " | 43 |
| " 1 x 10 | 24 | 3 | 10d. " | 30 |
| " 1 x 12 | 16 | 3 | 10d. " | 35 |
| " 1 x 12 | 24 | 3 | 10d. " | 25 |
| Flooring 1 x 4 | 16 | 1 | 8d. " | 27 |
| " 1 x 6 | 24 | 1 | 8d. " | 12 |
| " 1 x 6 | 16 | 2 | 8d. " | 36 |
| " 1 x 6 | 24 | 2 | 8d. " | 24 |
| " 1 x 8 | 16 | 2 | 10d. " | 36 |
| " 1 x 8 | 24 | 2 | 10d. " | 26 |
| Ceiling 3/8 x 4 | 24 | 1 | 6d. finishing | 6 |
| " 5/8 x 6 | 24 | 1 | 6d. " | 4 |
| " 7/8 x 6 | 24 | 1 | 8d. common | 12 |
| Siding 1/2 x 4 | 16 | 1 | 8d. finishing | 15 |
| " 1/2 x 6 | 16 | 1 | 8d. " | 10 |

**Estimating quantities of nails.** The accompanying table gives the number of wire nails in pounds for various kinds of lumber, per thousand feet board measure, allowance being made for loss of covering surface due to lap or matching of material. The sizes given are as rated on the market.

Shingles, per 1,000, require 3½ pounds of 3d., or 5 pounds of 4d. nails. Lath, ordinary, per 1,000, studding spaced 16-inch centres, 8 pounds of 3d. common wire nails. Bridging, per set for 2 x 10 joists spaced 16-inch centres will require 26 pounds of 8d. common wire nails per 1,000 linear feet of bridging.

Framing studding will require 15 pounds of 10d., and 5 pounds of 20d. nails, per 1,000 feet of studding.

Framing joists will require approximately the following amounts of 20d. nails per 1,000 feet:

| | |
|---|---|
| Frame buildings, 16-inch centres . | 15 lbs. |
| Brick buildings, 16-inch centres . | 10 lbs. |
| Brick buildings, 12-inch centres . | 12 lbs. |

Finish seven eighths inch, will require about 20 pounds of 8d. finishing nails per 1,000 feet, while 1¼ inches will require 30 pounds of 10d. finishing nails per 1,000 feet.

## Loads on Structures

Sometimes it becomes necessary to calculate the loads on a structure, in order to determine the exact size of timber required. The loads on a structure may be divided as follows: The *dead load* is the weight of the material of which the structure is composed. The *live load* is the weight of the various articles in the building that are not a part of the stucture itself. The *snow* and *wind loads* are, as the names imply, loads that are caused respectively by snow and wind.

In calculating the loads on a structure for the purpose of determining the size of timber or thickness of walls that may be required, with the view of building safely but without waste, the live load must be added to the dead load in figuring the total load on a floor beam. The snow and wind loads must be added to the dead load for figuring the total load on a rafter. All loads combined must be figured in calculating the size of foundation footings.

The accompanying tables (on this and the next page) will be found useful in calculating the live and dead loads on structures:

WEIGHT OF BUILDING MATERIALS PER SQUARE FOOT

| NAME OF MATERIAL | POUNDS PER FOOT |
|---|---|
| Corrugated (2½ inch) | |
| No. 26 galvanized iron . . | .99 |
| No. 28 galvanized iron . . | .86 |
| Felt and pitch roofing without sheathing . . . . . | 3 |
| Glass ⅛ inch thick . . . . | 1½ |
| Lead ⅛ inch thick . . . . | 6 to 8 |
| Lath and plaster (ordinary) . | 6 to 8 |
| Sheathing 1 inch thick | |
| Hemlock . . . . . . . | 2 |
| Spruce . . . . . . . | 2 |
| Yellow pine . . . . . . | 3 |
| Chestnut . . . . . . . | 4 |
| Maple . . . . . . . | 4 |
| Ash or Oak . . . . . . | 5 |
| Sheet iron 1-16 inch thick . | 3 |
| Shingles 5 inches to weather . | 2 |
| Steel roofing . . . . . | 1 |
| Tile, Spanish roofing . . . | 8½ |
| Tile, plain . . . . . . | 18 |
| 4-ply gravel roofing . . . | 5½ |
| 3-ply asphalt roofing . . . | 6 to 10 |

WEIGHT OF BUILDING MATERIALS PER CUBIC FOOT

| MATERIAL | POUNDS PER FOOT |
|---|---|
| Brick work . . . . . . . | 125 |
| Concrete . . . . . . . | 140 |
| Earth, dry . . . . . . . | 90 to 100 |
| Iron, cast . . . . . . . | 450 |
| Limestone . . . . . . . | 146 to 168 |
| Masonry, limestone . . . | 150 |
| Quicklime . . . . . . . | 53 |
| Sand, dry . . . . . . . | 90 to 100 |
| Steel, structural . . . . | 489.6 |
| Tile . . . . . . . . . | 110 to 112 |

To find the correct size of beam required to support farm produce, first find the total weight of such live load per square foot of floor area upon which it is to rest. Then find the number of square feet of floor area supported by one beam, and multiply this by the live load per square foot just referred to. This gives the total live load to be supported by the beam and by referring to the second table on page 374, the right size of beam can be located at once.

## WEIGHT OF FARM PRODUCTS PER CUBIC FOOT, IN POUNDS

| PRODUCT | WEIGHT | PRODUCT | WEIGHT |
|---|---|---|---|
| Barley | 38 | Hay, Alfalfa, in bales | 12½ to 14 |
| Beans | 48 | Hay, Clover, in bales | 14 |
| Beets | 44 | Hay, Clover, loose | 4.6 |
| Bran | 16 | Land plaster | 80 |
| Buckwheat | 39 | Potatoes, white | 48 |
| Butter | 59 | Potatoes, sweet | 41 |
| Cabbage | 40 | Rye | 45 |
| Carrots | 40 | Meal | 37 |
| Cheese | 30 | Middlings | 32 to 38 |
| Clover seed | 48 | Milk | 65 |
| Corn on cob, husked | 56 | Oats | 26 |
| Corn on cob, unhusked | 58 | Peanuts | 18 |
| Corn, shelled | 46 | Silage (at top) | 19 |
| Corn meal | 38 | Silage (at 36 feet) | 61 |
| Cottonseed | 25 | Straw | 19 |
| Eggs | 68 | Wheat | 48 |

## SAFE LOADS, IN POUNDS, UNIFORMLY DISTRIBUTED FOR YELLOW-PINE BEAMS

(SUPPORTED AT BOTH ENDS)

| SPAN IN FEET | SIZE OF BEAM | | | | | |
|---|---|---|---|---|---|---|
| | 2 x 6 | 2 x 8 | 2 x 10 | 2 x 12 | 2 x 14 | 2 x 16 |
| | DRESSED TO THE FOLLOWING SIZES | | | | | |
| | 1⅝ x 5⅝ | 1⅝ x 7½ | 1⅝ x 9½ | 1⅝ x 11½ | 1⅝ x 13½ | 1⅝ x 15½ |
| 6 | 1,714 | 3,047 | 4,488 | 7,163 | 9,872 | 14,020 |
| 8 | 1,285 | 2,285 | 3,666 | 5,372 | 7,404 | 10,515 |
| 10 | 1,028 | 1,829 | 2,933 | 4,298 | 5,923 | 8,412 |
| 12 | 857 | 1,523 | 2,444 | 3,582 | 4,936 | 7,010 |
| 14 | 734 | 1,306 | 2,095 | 3,070 | 4,231 | 6,008 |
| 16 | 642 | 1,142 | 1,833 | 2,686 | 3,702 | 5,256 |
| 18 | ........... | 1,016 | 1,629 | 2,388 | 3,291 | 4,505 |
| 20 | ........... | 914 | 1,466 | 2,149 | 2,961 | 4,206 |
| 22 | ........... | ........... | 1,333 | 1,954 | 2,692 | 3,823 |
| 24 | ........... | ........... | 1,222 | 1,791 | 2,469 | 3,505 |
| 26 | ........... | ........... | ........... | 1,653 | 2,278 | 3,235 |
| 28 | ........... | ........... | ........... | 1,535 | 2,115 | 3,804 |
| 30 | ........... | ........... | ........... | ........... | 1,974 | 2,804 |
| 32 | ........... | ........... | ........... | ........... | 1,851 | 2,628 |

Loads above heavy horizontal lines are calculated for both strength and stiffness. Loads below heavy horizontal lines calculated for strength only, and will deflect more than one thirtieth of an inch per foot of span, and should not be used with plastered ceilings.

**Barn framing.** In case the framing timbers for the barn are to be cut out of the woodlot with a portable saw, it may be best to use the old style of heavy-timber construction in some cases, because this takes less pieces and thereby reduces the amount of sawing, although the actual number of board feet of lumber is more than required for a plank-frame barn.

Figs. 525 and 527 show the method of building the heavy-timber barn; and below is a list of the parts, giving their names and average sizes used. The numbers at the left of each item in this list coincide with the numbers in the illustration.

PARTS OF A HEAVY-TIMBER BARN

| | NAME OF PART | SIZE | | NAME OF PART | SIZE |
|---|---|---|---|---|---|
| 1. | Basement sill . . . | 10 x 12 inches | 15. | Purlin braces . . . | 3 x 4 inches |
| 2. | Basement posts . . | 12 x 12 " | 16. | 3-ft.-run brace . . . | 3 x 4 " |
| 3. | Main sill . . . . | 10 x 10 " | 16½. | 2½-ft.-run brace . . | 3 x 4 " |
| 4. | Cross sill . . . . | 10 x 10 " | 17. | 3½-ft.-run brace . . | 3 x 4 " |
| 5. | Main post . . . . | 8 x 8 " | 18. | End girts . . . . | 4 x 6 " |
| 6. | Centre post. . . . | 8 x 8 " | 19. | Side girts . . . . | 4 x 6 " |
| 7. | Main beams . . . | 8 x 10 " | 20. | Door girts . . . . | 4 x 6 " |
| 8. | Main plate . . . . | 8 x 8 " | 21. | Breast girt . . . . | 6 x 8 " |
| 9. | Purlin posts . . . | 6 x 6 " | 22. | Breast-girt studs . . | 3 x 4 " |
| 10. | Purlin beams . . . | 6 x 6 " | 23. | Ladder post . . . | 3 x 4 " |
| 11. | Purlin plate . . . | 6 x 6 " | 24. | Door posts . . . . | 4 x 4 " |
| 12. | Upper rafters . . . | 2 x 6 " | 25. | Overlays, top and ends flatted to . . . | 6 " |
| 13. | Lower rafters . . . | 2 x 6 " | | | |
| 14. | Purlin girts. . . . | 4 x 6 " | 26. | Sleepers. . . . . | 6 x 6 " |

## Plank, Braced-rafter, and Plank-truss Types of Construction

**Plank construction.** The steady increase in the price of lumber and building materials has necessitated a closer calculation of their strength. Economy prescribes that each piece shall be only as large as needed to withstand safely the strains to which it will be subjected, and that it shall be so placed that it will be strongest in its allotted position. In the largest and best barns built to-day, you will seldom see timber thicker than 2 inches. This is partly due to the fact that small dealers carry a limited assortment of sizes, and, to a greater extent for the present-day calculations of architects.

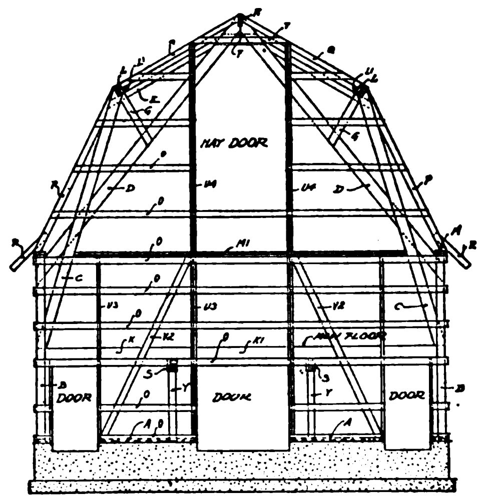



FIG. 531. End framing of a barn 36 feet wide with 16-foot side walls, built according to the plank-truss type of construction.

Most modern barns are built with self-supporting roofs, as this type of construction eliminates heavy beams and posts and reduces cost. This type of roof resembles the hull of a boat turned upside down, and consists of built-up plank arches reinforced with splice braces at angles, spanning from one side wall to the other. This roof, usually, has 4 surfaces, the lower 2 being steep, and the upper ones about quarter-pitch. Many make the mistake of calling this type a "hip roof." Its proper name, however, is "gambrel roof" and it is known also as "curb roof" and "mill roof."

Fig. 531 illustrates the construction of a favorite type of modern barn, which consists of a frame structure, the frame of which is built entirely out of planking not over 2 inches thick and on a concrete foundation which extends far enough above floor and outside ground level to prevent moisture from coming into contact with the wooden sill and frame.

The sill should be well bolted on top of the concrete foundation; and the studs are 2 x 6-inch in size for barns of ordinary dimensions, and spaced 16 to 24 inches on centres, the 24-inch spacing being preferred because any stock-length boards can be nailed thereto without waste. The studding is generally of 14- or 16-foot lengths, and has a doubled 2-inch plate spiked on top, which ties the studs together, keeps them in a straight line, and forms a sill for the rafters.

The floor joists of the hay-mow floor are made of 2 x 10- or 2 x 12-inch joists, as the weight of hay may require, and are spaced the same as the studding, so that the end of

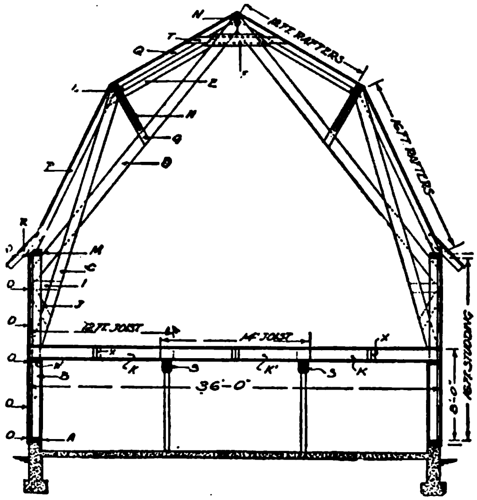


FIG. 532. Section of barn illustrating plank-truss construction, which, at the cost of a little storage space, makes use of lighter and therefore more easily obtained materials, than do other types of barn framing.

each joist may be spiked against the side of the studding and at the same time rest on a 2 x 6-ledger or "ribbon," which is notched 1 inch into the studding and continues the full length of both side walls with as few joints as possible. Three lengths are generally required to reach from one side of the barn to the other. The ends of the middle tier of joists are spiked and lapped against the ends of the 2 outer tiers, so that each set of joists forms a continuous tie from one side wall to the other, to take up the outward thrust of the roof; and the joists are supported under the lapped ends on a set of girders, built up out of 4 thicknesses of 2 x 10- or 2 x 12-inch joists, built up continuously from one end of the barn to the other with as few lengths of plank as possible and all end joints broken, so that there will be not more than one end joint at any one place along the length of the barn. These floor beams are supported by posts or, preferably, iron columns, which are so placed that they will intersect with the line of stanchions and the partitions between the stalls, and rest on concrete piers below the concrete floor.

**Stay bracing.** As this article is written more particularly for the inexperienced builder, it may be well to mention that as soon as the studding are set in place, they should be well braced against wind, and as soon as the joists are in place, more braces should be added. These braces should remain until the siding is in place and the roof has been completed, when they may be taken out.

**Framing the roof.** In framing the roof one set of rafters is carefully laid out on the hay-mow floor or other convenient level platform; and, after the exact length of each piece is computed, these are used as patterns, and the required number of pieces are cut from this one set of patterns. When all rafters, braces, ties, and collar beams have been cut, each set of rafters, braces, ties, etc., is spiked together, so as to form a complete arch rib which will reach from the plate of one side wall to that of the other.

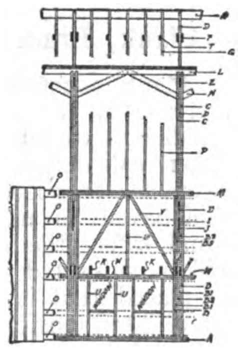


FIG. 533. Side elevation of plank-truss barn construction showing details.

The best method of procedure is to build all of these arches laid flat, one on top of the other, on the building. The ends of one arch (the heels of the lower rafters) are raised to the wall plates and then the point of the arch is hoisted to a vertical line, plumbed and spiked into place, and braced.

Each arch is nailed to several sheathing boards, which are used as guides and ties to secure the arches as soon as they are raised; and each arch is braced to the studding as soon as set in place. These arches can be raised and set in place by 3 or 4 men, while with the old method of heavy purlin-and-post construction, 10 or 15 would be necessary to help hoist the heavy frame.

This type of frame has the advantage of requiring less material and labor than the heavy timber frame; it is just as strong, and it forms a mow without any obstruction.

**Braced-rafter construction for basement barns.** If a superstructure of the braced-rafter type is built on top of a basement of wood or masonry walls, the joist of the floor which also forms the basement ceiling are set in place and the flooring is laid to within about 12 inches of the outside edge. This floor can then be used as a working platform upon which to build the braced-rafter barn.

Each set of studding, lower rafters, and upper rafters are all completely nailed, together with the braces and tied at the corners, so as to form a complete arch; and these arches are raised into place one at a time, starting at one gable end which is raised and braced first.

With this method of raising, no scaffold is required, but each arch should be well stay-lathed as soon as it is raised and plumbed. It saves labor in framing, as all the heavy nailing is done on the floor instead of in the air.

In this type of barn, the double plate at the top of the studding is omitted, and this joint is tie-braced just as the joint between the lower and the upper rafters is framed.

The narrow matched siding running horizontally is preferred, as it ties the arches together at the studding, just as the sheathing ties them together at the rafters. If vertical siding is desired, place continuous 2 x 4-inch nailing girts on the face of the studding, and break joints so that the girts will form a continuous hoop, or tie, around the building.

**Gable-end bracing.** The gable ends of the braced-rafter barn should be braced by using double 2 x 12-inch plates on top of the lower studding; and these gable plates should be braced across the corners to the plates of the side walls with 2 x 10 plank or with two 2 x 6's nailed together, so that one sets on edge and the other lies flat, thus being stiffened against hay pressure from both directions. The gable above the plate is braced by running 2 x 12-inch braces from the studding to the girders supporting the mow floor. These braces may be braced back to the gable, to counteract the hay pressure (Fig. 530). Fig. 528 illustrates the method of framing the ends.

**Ventilation flues for braced-rafter barns.** Wherever foul-air flues are to be built into the side walls, they may be easily formed by substituting 2 x 12-inch studding in place of the regular 2 x 6-inch size, to form the sides of the flue; also, 2 x 12-inch, should be used for the lower rafters and braces at the plate at all places in the roof containing these flues.

After the siding and sheathing have been placed on the outside face of the studding and rafters respectively, cover this surface (inside the flue) with building papers and over this paper surface place another thickness of matched boards, running vertically, to form the outside wall of the flue.

Construct the wall of the flues exposed to the interior of the barn, built in sections, by nailing together two thicknesses of dressed and matched boards, with building paper between, the boards of one thickness running at right angles to those of the other thickness; and, after well nailing, place these sections against the interior edges of the 2 x 12 studding and nail in place, so that the boards on the inside of the flue run vertically and those on the outside run horizontally.

The bottom of the foul-air flues should have an air intake opening equal in area to that of the flue; and there should be another opening of equal area at the ceiling of the room which is to be ventilated, provided with an air-tight wooden cover, hinged at bottom, to swing out, and provided with a ratchet for regulating and closing this opening.

The flues should extend, in an air-tight construction, to the underside of the roof at such places as ventilators or cupolas are placed on the roof. The flues should be kept in as nearly a vertical and straight line as possible.

The air from the mow should never be taken out at the same cupola or ventilator that is expected to suck the air out of the flue. A separate ventilator for each flue will always give better results than two flues run into one ventilator.

**Plank-truss construction.** In certain parts of the country, it is advisable, owing to the long rainy seasons, to have barns with large floors which may be used for threshing or for unloading the hay wagons within the barn during wet weather.

This barn floor, or interior driveway, is most convenient if placed on a level with the mow floor, running crosswise of the barn. This requires very large doors in the side of the superstructure, which makes it necessary to have the side walls above the mow-floor level from 14 to 16 feet high.

These large openings also make it necessary to concentrate the support of the roof at certain points (between the wide doors) on the side walls. These conditions have developed the plank-truss type of barn construction (Figs. 531 and 532).

**Framing the plank-truss barn.** The entire dead load, wind load, and live load imposed on the superstructure of this barn is carried by the plank trusses, which are spaced from 12 to 16 feet apart. The total weight is consequently very considerable and the trusses must, therefore, be built carefully and strong and out of good, sound material.

Also the long members require extra strength against lateral-deflection.

The various members of each truss are bolted together, and upon each of these bolts rests a large responsibility. As a chain is no stronger than its weakest link, so this truss is no stronger than its weakest joint. The bolts should be carefully placed, and provided with large, thick washers at the head and nut ends, so that the tightening of the bolt will not crush the wood fibers about the bolt into worthless pulp.

The trusses, after carefully assembling, are raised into position and well braced; after this the studding is framed and set up (Fig. 533); then the purlin and its braces are placed, from a scaffold built on the mow floor; then the rafters are set in place, and the barn is ready for the inclosing lumber.

The ends are framed as shown in Fig. 531. Since the entire weight of this barn is carried by the trusses, it is not necessary to have so many wall studding between the trusses; and, because the studs are set farther apart, it is economy to use vertical siding on this type of barn.

This type of construction has been so successful in the sections of the country requiring a barn floor, that, through wide publicity, it has come into very extensive use in other parts of the country where the barn floor was not called for and has, consequently, been omitted. Under such conditions, the plank-truss barn will cost about 15 per cent more than the braced-rafter construction.

## The One-story Type of Barns

A great movement for better barns is now sweeping over the country. Better barns, however, not always mean large, expensively built, pretentious barns.

The farmer who desires to start with a small capital and, at the same time, build well and along scientific lines whatever he does build, may be interested in the 1-story type of barn construction, which will cost very much less to build per head of livestock capacity or per ton of hay capacity than either of the 3 double-story types previously described.

This 1-story type of construction consists of a 1-story shed for livestock, detached from or attached to a 1-story shed for hay storage. Some of the advantages of this type of barn are the following:

Both sheds need not be built at the same time. If capital is limited, the shed for the livestock may be built first and, if necessary, the hay may be stacked in the yard under a tarpaulin for the first season. This reduces the original cost to a very small amount.

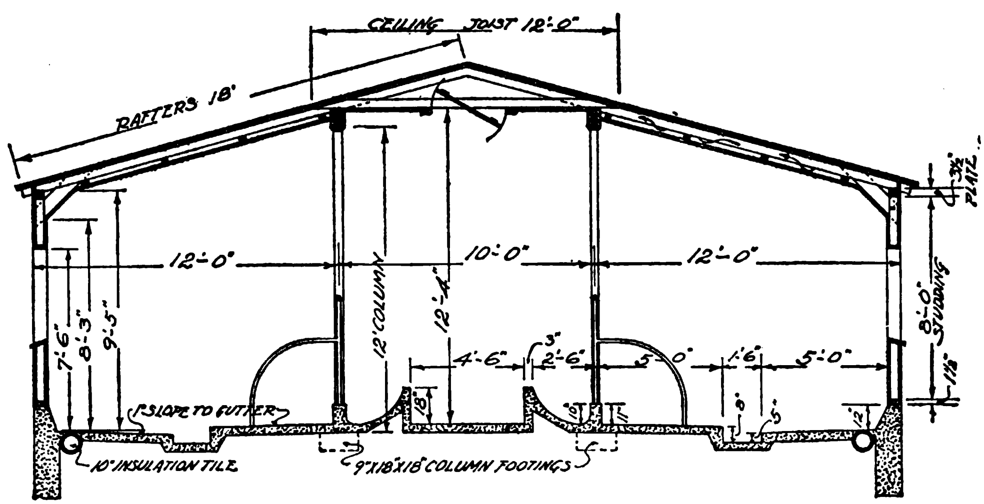



FIG. 534. Section of a single-story dairy cattle barn with concrete floor, metal interior equipment, double walls providing ventilation flues. It is arranged so that the cows face inward toward a central feeding alley. (See Chapter 34 for advantages and disadvantages of this plan.)

The hayshed, built to the north of the stockshed and at right angles to it, forming an L, gives protection from north winds to the stockshed and the exercise lot.

The storage of the hay on the same ground level with the stock saves labor in filling the mow, because the hay track is about 11 feet nearer the ground—a saving of about 60 per cent in hoisting the hay to the track.

Where first-class milk is produced in the 2-story barn, requiring hay to be thrown down from the mow above to a dustproof room at one end of barn, the 1-story barn saves labor in feeding hay, because it is not necessary to climb up a ladder to get to the mow and then to carry the hay to the chute.

It is more sanitary, because more dust is excluded from the cow barn by eliminating the hay chute, and fewer odors from the stock will reach the hay. The ventilating system is better, because the ceiling is arched and air can be taken out at the centre, when so desired. The greater height of the ceiling gives a greater air capacity per animal.

Risk by fire is lessened, because flames and heat will not reach the stock quickly, giving more time for driving out the stock; and, when the wind is in a favorable direction, there is a chance of saving the stockbarn when the hayshed burns.

Risk of storm is less, because the stock is in a low building, and the haybarn does not extend so high in the air.

Smaller timber may be used, because a light roof is all that the low side walls have to support; this, together with the fact that no heavy wooden hay-mow floor is needed, reduces the cost very much.

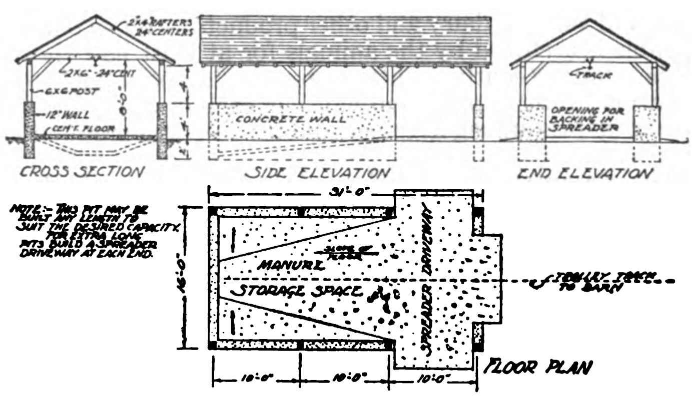



FIG. 535. Plans and dimensions of a concrete, covered manure pit, which in connection with well-built livestock barns and a manure spreader, enables the farmer to get the maximum benefit from his manure supply.

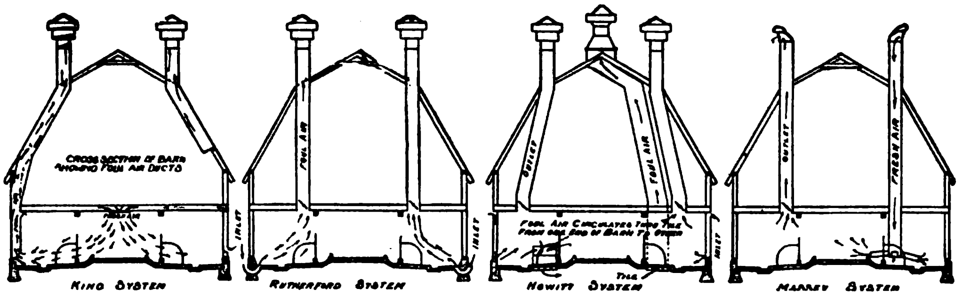


FIG. 536. Diagrammatic sections of combination dairy and storage barns illustrating the principles and method of operation of the four main types of ventilation systems

# CHAPTER 33

# The Equipment of Farm Buildings

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WHY is it that so many farmers who take much pride in the exterior appearance of their farm buildings manifest so little concern in their interior arrangements? On the latter depend, to a very large extent, the health of the stock and the output and value of dairy and other products. When one considers that the barn or stable is occupied by the animals for at least half the year, it is to be regretted that, until recently, so little attention has been paid to such matters as barn ventilation, water supply, and lighting, each of which is a vital factor in the prevention of disease among livestock and in successful production and profitable farming.

While much improvement along these lines has been made during the past few years, a journey through the farms in any of the states will reveal to the visitor the existence of numbers of dark, damp, ill-ventilated, and poorly equipped barns, which are obviously behind the age with regard to agricultural progress. The aim of the present chapter is the remedy of such conditions by offering to the farmer (1) some useful hints on what to avoid in farm-building equipment and (2) some practical suggestions, set forth as simply as possible, in regard to cleanliness, sanitation, and the saving of labor, which together contribute so largely to increased production and to success in farming generally.

## Ventilation

The importance of proper ventilation is now recognized by all livestock farmers. It has been fully demonstrated that good ventilation in a barn means less food consumption, greater production, and healthier animals. There is no single factor of greater importance in the control of tuberculosis than fresh air; and for this reason, if for no other, the question of ventilation is of vital interest to all dairymen.

There are 4 good reasons for ventilating a barn: (1) to maintain proper temperature; (2) to remove foul air and the moisture of respiration; (3) to prevent spontaneous combustion in the mow; and (4) to provide pure, fresh air for the animals.

A dairy cow requires, for proper ventilation, approximately 3,600 cubic feet of air per hour, which is only a little more than that which the natural heat from her body will raise from 0 to 50 degrees F. Thus, if flues of proper size are used, it will be easy to maintain a temperature of 45 to 50 degrees F. in the stable. The temperature in a dairy barn should not be allowed to drop below freezing.

If the air in a stable or dwelling is not changed with sufficient frequency it becomes so damp as to interfere with the respiratory organs. Dampness in a barn is an indication of poor ventilation. Each animal respires 10 pounds of water every 24 hours, or, in other words, 20 cows will give off a little less than a barrel of water a day.

Many fires on the farm, usually resulting in a total loss of building and contents, are caused by the storage of green leguminous hay in the barn. These fires are caused, by confining the heat and the gases which are given off during the curing of the hay. With proper ventilation, these gases are carried off as formed and do not reach the high temperatures which cause them to ignite.

Oxygen is just as important a part of the nourishment of cows and horses as the food they eat. It is essential to have plenty of pure air for the lungs of all animals and to prevent the moisture of respiration from collecting on the walls.

Four forces which produce ventilation are: (1) wind pressure; (2) wind suction; (3) aspiration, or wind across the top of flue; and (4) difference in temperatures. These 4 forces must be considered in the design of any system of ventilation.

**Ventilation systems.** The most common systems of ventilation are the Massey, the Howitt, the King, and the Rutherford. These are sometimes supplemented by the use of ventilating windows or canvas curtains. In all of these systems, inlet flues are used to bring in fresh air, and outlet flues are used to remove the foul air and odors (Fig. 536).

The Sheringham valve, or ventilating window, is used primarily to supplement the King system during mild weather. It consists of a window tilting in at the top and provided with a shield on either side, forcing the air to go up over the top, thus preventing direct draft on animals.

Ventilation through muslin is due to current movement through the meshes which, in a good grade of muslin, are very small. If cheesecloth is used, it is short-lived. In spite of the fact that cloth is commonly used, it cannot be considered an efficient ventilator.

The Massey system has an inlet pipe running from the top of the barn and opening at the bottom of the stable. A cowl is placed on this pipe through which the wind blows downward, giving a circulation of air. When the wind is blowing, air is distributed in small pipes around the stable. This system is not in common use, as it depends principally upon the wind for its action.

In the Howitt system of ventilation, the air enters the barn through louvers or screened openings extending the full length of the barn and located near the ceiling. It passes down between the studding and out through a continuous slot just above the sill with two separate sets of foul-air flues, one set of outlets at the floor and one with openings at the ceiling. This system can be regulated to give good results in any kind of weather.

The King system of ventilation, which is the predominant system in the United States, has for its principal idea a number of small intakes and one or more large outlets. The fresh air enters above the sill, rises between the studding, and enters the stable at the ceiling. The outlet flues start near the floor, pass up inside of the barn, through the mow, and through the ventilator on the roof. The area of the outlets is generally made two thirds of or equal to the area of the inlets, depending on climatic conditions.

FIG. 537. Ventilating window with side shields or cheeks which prevent drafts. Opening inward, this style can be permanently screened on the outside.

In the Rutherford system, which is quite commonly used in Canada, the positions of the air inlets and outlets are just

the reverse of those in the King system. The fresh air enters the inlet flues at ground level, turns downward, passes inside, and rises into the stable. The outlet flues start at the ceiling, pass up through the mow, and out at the ventilator. The total area of outlet in this system is made twice that of the inlet.

**Importance of proper flues.** In order to secure good ventilation, it is important that the flues be made of proper size. The accompanying table gives the size of flue recommended for use with the Rutherford and King systems respectively.

| ANIMAL | SIZES OF OUTLAY FLUES | |
|---|---|---|
| | RUTHERFORD SYSTEM | KING SYSTEM |
| Horse . . | 20—24 sq. in. | 36—40 sq. in. |
| Cow . . | 16—20 " " | 30—34 " " |
| Swine . . | 8—10 " " | 12—14 " " |
| Sheep . . | 6— 8 " " | 8— 9 " " |

The constructon of the flues in both systems is quite similar, since they must be air-tight, but they differ in arrangement. In the King system, it is desirable to have intakes on all sides, spaced about 10 or 12 feet apart, and made as straight as possible with corners rounded. The inlet flue should be provided with a screen on the outside, to keep out birds and trash, and with a door, or register, on the inner end, to regulate ventilation. It should start far enough above the ground to prevent snow from closing the opening, and the outer end of the flue should be at least 3 feet below the inner end.

The foul-air flues should be spaced not over 40 or 50 feet apart, and should start about 18 inches above the floor. Each flue should be made air-tight and provided with a sliding door, or damper, for regulating the size of the opening. It should be made as straight as practicable and should rise above the ridge of the roof. High outlet flues are desirable, as the heat effect and suctional effect of the wind increase with the height.

Although the King system of ventilation has been used to some extent for years, there is, apparently, considerable ignorance concerning its principles. It is highly important that the size of flues be properly proportioned to suit the contents of the stable and climatic conditions. None of the systems is automatic but all of them require intelligent supervision in order to secure the best results; and these can only be obtained by a knowledge of the basic principles involved.

In the King system, the assumption is that respired air, laden with moisture and carbon dioxide, is heavier than air and falls to the floor, where it is drawn out by the action of the wind over the top of ventilator, assisted by the movement of air caused by the difference in temperature of the air inside the flue and outside of the barn.

The foul-air flue is provided with a valve, or door, which opens into the flue near the ceiling and permits warm air to go directly out during mild weather. This valve is an important item and should not be omitted, as it enables the system to be adapted to the weather conditions.

The question is not, Do I need ventilation? but, How can I secure best results? A careful study of the foregoing paragraphs should help in answering this question.

## Water Systems for the Barn

There is no factor of greater importance in farming and, perhaps none more often neglected, than that of providing suitable drinking water for farm animals. Our ideas of sanitation are advancing, however; and, in the future, greater care in the production of all foodstuffs will be demanded. Especially will this be the case in regard to a pure water supply in the dairy, since it bears such an intimate relation to the general health of mankind and particularly to that of the young child.

**Water storage.** There are many sources from which a good supply of water may be obtained, and when this has been secured the question of storage comes. Two systems of water storage are especially connected with the barn; (1) the elevated tank on the silo structure and (2) the tank within the barn.

(1) The masonry silo, of tile or concrete, provides an excellent means of supporting an elevated water tank. In this way, the additional cost of elevation is very little and the tank does not interfere with the use of the silo. This form of water storage provides the farmer with the luxury of a city waterworks and good fire protection on his own grounds.

The water tank should not be made larger than necessary and its construction should be left to those who are familiar with this kind of work. The accompanying cut and diagram (Figs. 538 and 539) show how such a tank has been utilized and the construction of the same. This system is as yet but little known; but, with the increased use of the masonry silo, we may expect to see a greater number of elevated tanks in the future.

There is, however, one drawback in using

this system in northern states: it is difficult to keep the pipes from freezing during cold weather. This difficulty may be partially overcome by insulating the pipes with straw or sawdust. If fresh water from the well is pumped up each day, the warm water from the well will tend to lessen the danger from freezing.

The arrangement partly illustrated in Fig. 539 tends to keep pipes from freezing: A three-fourth inch pipe is placed within a 2-inch water pipe, the upper end running above the water level, and the bottom end running to the base of the silo. The lower end is provided with suitable fitting and a shield opening into the pipe. Below this shield a lantern may be hung on cold nights the warm air from which, rising through the pipes will diminish the chances of freezing and in case of freezing will also help to thaw them out.

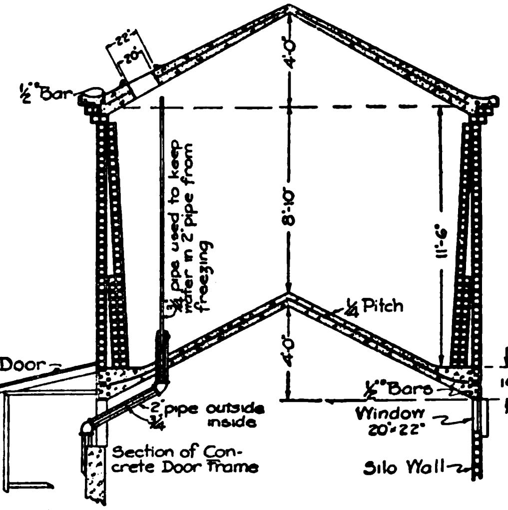


FIG. 539. Section of a hollow tile water tank built on top of a tile or concrete silo, the roof of which is shown

(2) A tank placed inside of the barn on the mow floor may be used for water storage. In this position it can be packed with hay, which lessens the danger from freezing. Eave troughs placed on the barn can easily be run into this tank. Such water is usually cleaner than that obtained from the roof of a house, as the barn roof is free from soot. If a filter be provided, the water may be used for human consumption.

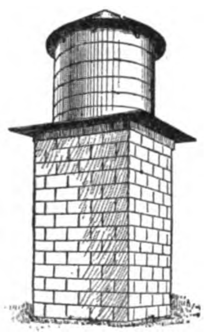


FIG. 538. Water tank elevated on masonry base which can be used as a silo or storage building.

**Watering stock.** The methods of watering stock on a farm may be divided into 2 classes; (1) the open-tank method in the feed lot, and (2) the various methods inside the barn.

(1) The water tank in the feed lot is widely used. It is convenient, and low in first cost; but when water is stored in it for any length of time, it becomes stale, and affords an excellent breeding place, for disease germs. Diseased animals slobber in the tank and infect other animals. Water is known to be a carrier of tuberculosis, glanders, and contagious abortion, all of which are greatly dreaded by herdsmen. It has been estimated by some authorities that 65 per cent of the tuberculosis found among cattle in the United States has been transmitted through water.

A green, mossy formation gathers on the side of an open tank, but this may be prevented by cleaning and scrubbing the tank once a month. Another method which does not involve so much labor, but which should not entirely replace the periodic cleaning, is the use of copper sulphate in the water. Place a small amount of the crystals in a cloth bag and drag this back and forth through the water a few times. This will prevent the mossy formation.

Outside open water tanks are objectionable in the winter, as it is difficult to keep ice from forming in them. A cow should never be required to drink icy water, as she will drink only enough to satisfy her thirst and never enough to keep up her milk production. This is a direct economic loss.

Covered tanks help to keep the water from freezing. There are many forms of tank heaters on the market, but they are more or less troublesome. Most of them need to be fired from the top, and it is unhandy to take out the ashes. Water heaters are sometimes built into concrete tanks; but these also, are more or less unsatisfactory, since the heat causes the concrete to expand and contract, and this soon results in a leak. Where steam is used in a dairy, a pipe may be run to the tank and live steam turned on. This will warm a large tank of

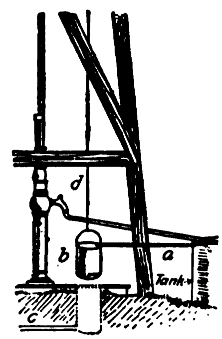


FIG. 540. Handy automatic device for controlling a windmill. When the tank overflows through *a* into the bucket (*b*), this sinks and stops the mill by pulling the shut-off wire (*d*) But a small hole in its bottom lets the water gradually run off through the drain (*c*). When *b* is empty, the vane action lifts it and holds it up until the tank again overflows.

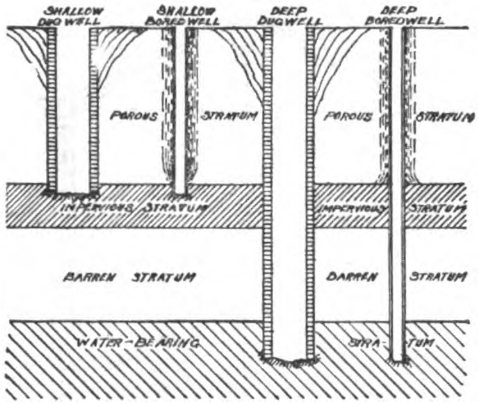



FIG. 541. Well sections show comparative chances of contamination in four types. The deepest water supplies are usually the safest. (Farmers' Bulletin 549.)

water in 5 minutes and, if covered, it will keep warm for some time.

It is not advisable to store large quantities of water in an open tank inside a stable, as the water will quickly absorb the stable odors and be unfit for use. If open tanks are used in a stable, small tanks should be used and means provided for renewing the supply frequently. The writer recently visited two barns which were fortunate enough to have running spring water under pressure in the barn. This is an excellent method for watering, but very few farms are so fortunately situated.

A dairy cow requires 8 gallons of water in the production of 10 gallons of milk, besides the water she needs to keep up her body. It does not pay to use high-priced feed to increase milk production and neglect the opportunity of obtaining an increase cheaply by providing an abundance of pure water. It will pay any dairyman to see that his cows are not required to go outside in stormy weather to drink. It has been found that water of a temperature of 55 to 60 degrees F., or the temperature of well water, gives best results. Watering in a concrete manger is better than driving cows outside during bad weather, but this method is far from sanitary. Water is usually run into the manger twice a day. All the cows drink from the same supply and often do not secure all they want and at the time they want it. The water washes down dirt, salivated feed, slobber, etc., to the cows at the lower end of the manger.

**Gravity water bowls.** By the gravity system of water bowls, one bowl usually serves two cows. This system requires only one main water pipe. The bowls are clamped to the stall post and at a uniform height. One end of the water main is attached to a governing tank containing a float valve, which controls the height of the water in the bowls. The water flows freely and intermingles between the bowls. There is no outlet except through the cows. The water bowls usually contain less than a thirsty cow will drink; hence whenever a cow quenches her thirst, water is drawn from the governing tank and adjacent bowls. Lids on the bowls help to keep out dirt.

This system is very convenient, but dangerous. Animals with a contagious or infectious disease drink and deposit germs in the bowls, where they mingle with the saliva and feed and surge back and forth in the pipes. These germs soon propagate, causing the bowls and pipes to become unsanitary, and the pipes are very difficult to clean.

It is said that, when cows have free access to water at all times they drink at least 10 per cent more at night after eating than they do in the daytime. Under these conditions, it is not hard to see why those farmers who

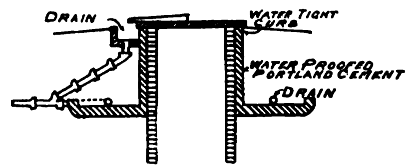



FIG. 542. A simple but effective method of protecting a dug well, which also keeps the ground around it dry

have installed automatic water bowls in their barns have been able to increase their milk production 5 to 15 per cent.

**Automatic water bowls.** Automatic water bowls (Fig. 543) are of two types. One has outlet pipes or drains, the other has no drains. Both are actuated by some form of trigger work, which is operated by the cow. The one without the drain provides for an individual drinking cup; but this is little better than the gravity bowl, as the feed and saliva collect in the bowl and are stirred up each time a cow drinks. In order to be strictly sanitary, water must be admitted at each drinking, and all excess water drained away when the cow has finished drinking. The inlet pipe should be above the highest level in the bowl, and in the bottom of the bowl a drain should be placed.

FIG. 543. Individual drinking bowls are more costly than a common tank for all the stock, but one valuable cow saved from disease by means of them would more than balance the account.

Water pipes should be placed in trenches to prevent them from freezing in cold climates, and they should be provided with frost-proof hydrants. All

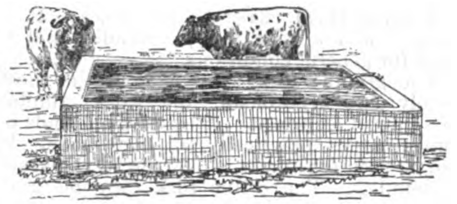


FIG. 544. A concrete watering trough is permanent and can easily be kept clean. It should be conveniently placed and well sheltered.

pipes should be of galvanized wrought iron and of such sizes as to allow a free flow of water. Not more than one outlet should be used on a half-inch pipe; and all valve and drain cocks should be set in gravel, so that they will drain easily.

The tuberculin test is of value in detecting a diseased animal, but it does not prevent her from infecting another. We have seen how contagious abortion and tuberculosis may be transmitted through methods of watering and feeding, hence we cannot be too careful in choosing our system of watering.

In estimating the amount of water necessary for barn use, the following data will be of value: A horse requires 8 to 10 gallons per day; a cow, 10 to 15 gallons; a hog, 2½ to 3 gallons; and a sheep, about 2 gallons. A dairy cow requires water in proportion to the amount of milk given, the ratio being about 2½ pounds of water for each pound of milk.

## Labor-saving Appliances

The modern agriculturist no longer builds in a hit-and-miss fashion. He carefully plans his buildings and equipment so as to secure the greatest possible returns on his investment. Breeders of high-grade livestock find that it pays to use first-class equipment, complete in every detail, as this makes a favorable impression on prospective buyers. Producers of certified milk, too, find that they are able to secure more customers and better prices by using sanitary equipment. But the wide use of modern barn equipment on the average farm is largely due to the saving of feed and labor and the additional comfort for the animals resulting from its employment.

Good barn equipment is no longer considered a luxury, but a necessity which pays daily interest on investment by saving material, time, and labor. The various labor-saving devices for the barn may be divided into 3 classes: (1) conveniences for handling feed and litter; (2) conveniences for handling stock; and (3) miscellaneous conveniences, which help to increase the efficiency of the barn.

**Hay tools.** The hay carrier was, perhaps, the first important labor-saving device invented for use in the barn. It made possible the storage of large quantities of hay in the barn and has introduced more economical types of construction for hay storage. Indeed, no large modern barn is complete without one. The scarcity of labor during the haying season and the increased value of hay make it imperative that we use every means available to facilitate the handling and the saving of the hay crop.

The original hay carrier was operated on a wooden track,

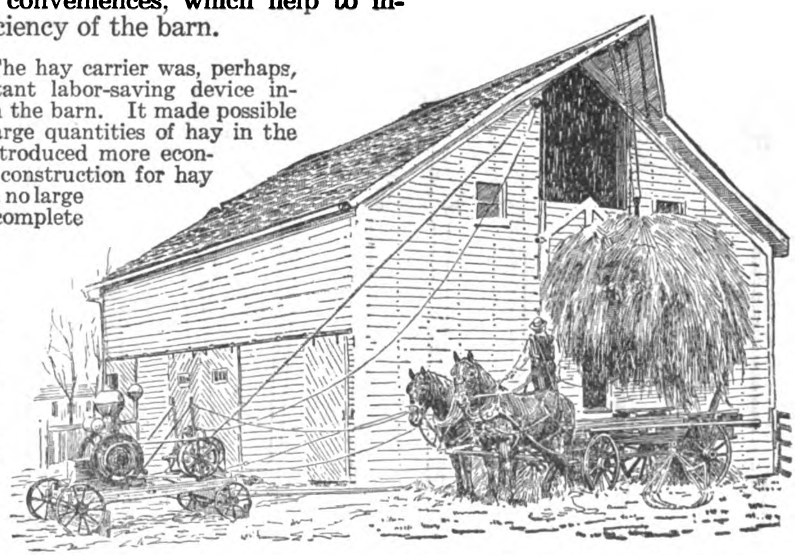


FIG. 545. An excellent example of the use of labor saving appliances. Four men and an extra team could not unload and stow hay as fast or as well as this one man can by using the hay carrier rigging and hoisting engine.

and this is still used in some localities. The steel track, of which there are many forms on the market, makes the carrier much easier to operate, and is greatly superior to the wooden one. Simplicity, durability, and strength are 3 important factors to consider in the selection of a hay carrier. It should be simple, so as to be easily understood and operated. It must be durable and strong enough to support the loads. Breakage during the haying season is expensive because of loss of time in repairing and this delay may very easily cause a partial or a complete loss of the hay crop, in case of a sudden storm.

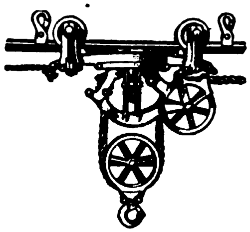


FIG. 546. The hay carrier is one of the most important items in the storage barn equipment.

**Hay forks.** The different hay forks which are suitable for barn use may be divided into 5 types: (1) single harpoon; (2) double harpoon; (3) triple harpoon; (4) grapple fork; and (5) sling.

The single harpoon (Fig. 547*a*) is the original hay fork. It will do good work in long, heavy timothy hay and where the hay is carefully loaded and handled in small bunches. It is not so successfully used in clover or alfalfa, especially when the hay is dry. The double harpoon (Fig. 547*e*) has been on the market for years, and will do good work in timothy hay and under average farm conditions. The triple harpoon (Fig. 547*c*) is a later invention. This fork is much stronger than the double harpoon, and will lift larger loads and bring them closer to the track. It is durable and a light fork to handle, and is good for general conditions.

The grapple fork (Fig. 548) is the most widely used type of all, and works similar to a pair of ice tongs. It handles all kinds of forage under practically all conditions. It can be used for alfalfa, clover, straw, or grain in bundles. The 8-tine fork may be used for manure. This fork increases in popularity each year.

The sling (Fig. 549) is used for handling hay in large loads. It handles the hay quickly and cleans the rack perfectly. It consists primarily of a set of parallel ropes, held apart by wooden spreader bars, and is made in a great variety of styles. It is built into the load at the time of loading. It requires large door openings and good clearance over beams.

The various types of forks require different sizes of hay doors, in order to get good clearance. The single harpoon may be used in a door as small as 5 x 7 feet. The 6 x 8 size is better, as it causes less binding. A door 8 x 10 may be used for the double harpoon, while the triple harpoon requires a door 9 to 10 feet wide and 10 feet high. A door 9 to 10 feet wide and 10 to 11 feet high should be used with the grapple fork; and, when slings are used, the door should be 10 x 12 feet.

**Power hoist.** The power hoist (Fig. 545) is rapidly coming into use where large quantities of hay are handled. It is conveniently and easily operated, and saves much time and labor during a busy season. It displaces a man and a team which are necessary when hoisting with horses. The horsepower required depends upon the size of the load and

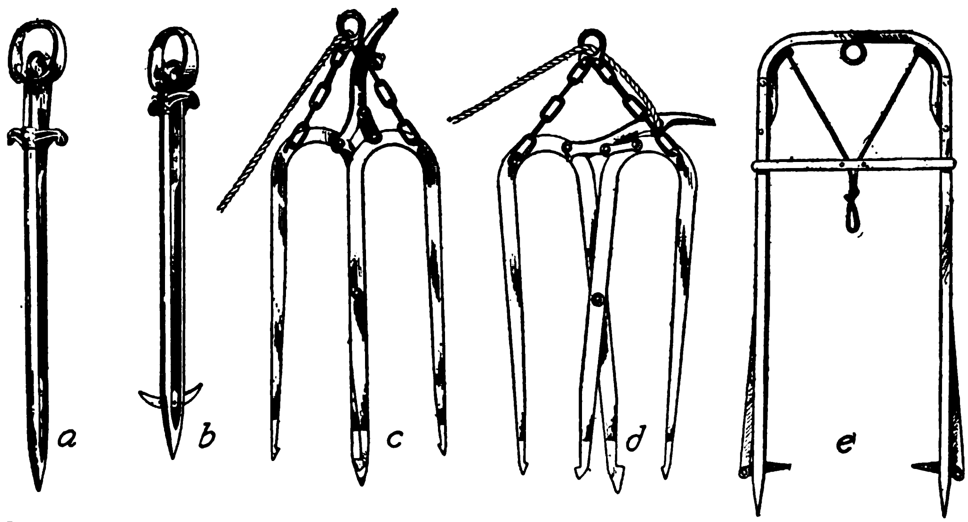



FIG. 547. Types of hay forks: *a* and *b* single harpoon, open and closed; *c* and *d*, triple harpoon open and closed; *e* double harpoon closed. This type is opened by pulling the rope loop in the centre

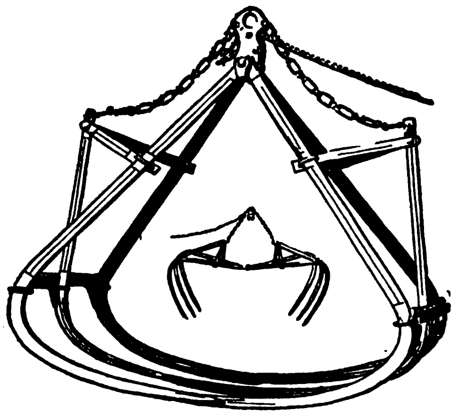


FIG. 548. The grapple type of hay fork is probably the best of all for mixed and miscellaneous hays

the speed of the engine. It is usually from 3 to 5.

The value of the power hoist is greatly increased by the fact that after haying season it can be mounted with a portable engine and used for general farm purposes, such as digging wells, elevating grain in sacks or boxes, constructing silos, hoisting silage from pit silos, etc.

**Feed and litter carriers.** Anything that adds to milk production or makes it more profitable, is of importance to the dairyman. Litter and feed carriers are great conveniences which aid in cutting cost by reducing the time and labor required for the barn chores. The hay carrier cuts labor and time during the haying season, and is now recognized as a necessity; but feed and litter carriers are of even greater importance, since they save time and labor in the daily tasks.

By using a litter carrier, manure may be dumped directly into a manure spreader and taken to the field with only one handling. It enables a boy to do a man's work, and thus decreases the hired help needed. It has often been proved that it cuts the labor of cleaning a barn in half. The old wheelbarrow is still used in many barns, but it is a disagreeable method of handling manure. By this method the manure is usually dumped in piles near the barn, requiring a second handling before it is put in the field. With the modern litter carrier, manure may easily be deposited 50 feet or more from the barn. The sanitary laws of many states require the observance of this distance, which takes the filth away from the barn and helps to decrease the number of flies.

**Carrier tracks.** In order that both feed and litter carriers may last longer and be operated more easily under heavy loads, the trolleys used should have roller bearings and should run on a solid steel track. There are two general types of steel tracks used for litter carriers; namely, the rigid steel track, of which there are many forms on the market, and the steel-rod track. The steel-rod track may be used in the small dairy barn, and is cheaper; but it is not advisable where curves and switches are necessary. The rigid-steel track may be used anywhere, and it provides a good strong support for the heavy loads. Moreover, it is much easier to load a carrier on a rigid track.

There are now on the market several combination track systems which combine the advantages of the rigid track inside the barn with the advantage of the rod track outside the barn. By this system enough momentum can be given the carrier to take the load away from the barn and return the carrier by gravity without the necessity of the operator leaving the barn. This system is suitable for small installations; but the rigid-track system is best for large installations, where numerous switches and curves are required.

Feed carriers may be run on the same track as litter carriers and may be either of two types. Of these types one runs on tracks like litter carriers; the other has a feed box placed on a truck which runs on the floor. Both types are widely used. The floor trucks may be conveniently used when the feed is stored in the barn and the floors are of the same level. Outside the barn, it is much easier to use the track carrier, which is more generally employed than the floor feed truck. These carriers are made in various sizes and forms, to fit the conditions found on different farms. A carrier will hold enough silage to feed 25 or 30 cows; and by this means one man can feed 100 cows as quickly as another man can feed 50 or less by the old basket method.

Carriers may also be obtained for handling milk cans and other forms of merchandise. These help to cut down the time and labor of transporting milk from the barn to the dairy.

**Mangers.** Sanitary dairy barns have been made possible by the use of concrete mangers and steel stalls. Concrete is rapidly replacing wooden mangers and other wooden and, therefore, more or less unsanitary parts in the dairy barn. Wood forms an excellent harbor for disease germs and other bacterial life, which penetrate the cracks and crevices and lie dormant until conditions favor their propagation.

A properly constructed manger is a very important factor in maintaining the health and comfort of the animal. Wide, flat-bottom mangers are not advisable, as it is very hard for the cow to reach her food in them. In attempting to do so she often slips on the floor and injures her knees, which is the cause of big knees. She may also easily strain herself and cause abortion.

The shape and size of the mangers determine whether a cow can eat in comfort. The bottom should slope and be rounded, so that the feed will roll down within easy reach.

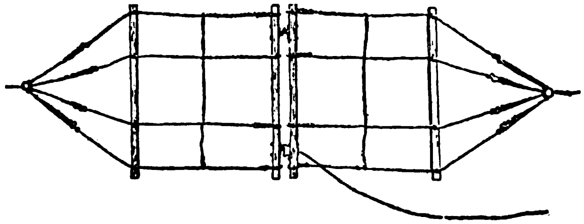


FIG. 549. Hay slings do more and cleaner work than any of the forks, and the trouble of arranging them on the load in the field is not worth mentioning.

The surface of the concrete should be made as smooth as possible and all corners be rounded off, so as not to hold dust and filth. Three different mangers are widely used throughout the United States and have become standard among dairymen. One of these is a manger which is adopted under crowded conditions, and it is as small a manger as can be conveniently used. This manger has the disadvantage of a raised or high feed alley, and the food is pushed out into the alley with the same results as previously mentioned. The cows attempt to reach it, and in so doing very often injure themselves. This type of manger is preferred by some farmers, however, because it is easy to sweep the food back into the manger. This is bad practice, as dirt and other filth are thus drawn into the manger and mixed with the food. Another manger is of standard size for the average cow and for average conditions, while a third is used for large cows and where a higher manger is desired. The last-mentioned type is easily kept clean; the feed is always within reach of the animal, and the curve of the manger is the approximate curve described by the cow's nose in raising and lowering her head. The first and third types are shown in Vol. I, Fig. 513.

Stanchions. Comfort for the dairy cow pays big dividends. A cow is a nervous animal, and, when ill treated, will not produce well. When held in a stiff and rigid stanchion, she will not give her full quantity of milk; and, when held in this way for any length of time, she will soon become stiff and lame. The old-style wooden stanchions were not only inhuman and uncomfortable, but they were unsanitary also.

The best-paying piece of barn equipment is the modern tubular steel stanchion. The chain-hung flexible steel stanchion is now recognized as an ideal cow tie, as it embraces the features of safety, comfort, cleanliness, and convenience. The round-sloping-end stanchions are best, as they are much safer than the flat-bottom stanchion.

Steel stalls. The greatest protection against disease is sanitation. Sanitation in the dairy barn has been made possible by the advent of the modern steel stall and the use of concrete mangers and floors, which make it easy to keep the barn clean. Steel stalls are strong and durable and do not obstruct the light or ventilation. The stalls should be simple, with all fittings of the dustproof type, so that they may be easily wiped off and kept clean.

The partition is an important part of a cow stall and is necessary to prevent a cow from stepping on her neighbor and bruising her udder or crushing her teats when she is lying down. It is also useful in protecting the milker and in preventing the cow from turning sidewise and soiling adjacent stalls. The single-bend stall partition is the best as it is stronger than the triple-bend type, and with it there is less liability of injury to the cow.

It is important that the length of the stall be properly proportioned to the cow, in order

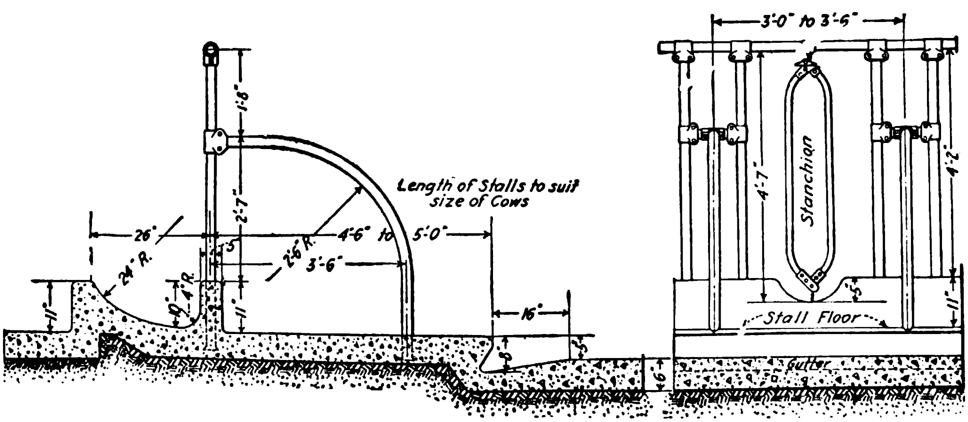



FIG. 550. Side and end views of a modern concrete floored cow stall and metal stanchion giving average dimensions or those that are uniform for all classes of stock

that she may be easily kept clean. The stall should be of such length that the cow may stand easily on the platform and all droppings may fall into the gutter. There are many alignment devices on the market for securing this result. These are an added expense, however, and are not necessary if the stall on one end of the row is made to fit the smallest cow and that on the opposite end is made to fit the largest cow, all intervening stalls being made accordingly. The cows may then be assigned to the stalls most convenient for them. Alignment devices are, however, very convenient where it becomes necessary to change the length of stall after the concrete work is finished.

The table shown below gives the sizes of stalls recommended for cows of various breeds, and for heifers.

Steel pens also aid materially in maintaining sanitation in the barn, as they admit the maximum sunlight and do not obstruct ventilation. Calves cannot do well in dark and damp pens, but they grow rapidly when kept in clean and well-lighted pens. This is a safe, sanitary, and humane way of caring for calves. Steel maternity pens are easily kept clean and easily disinfected. This is a big factor in reducing navel trouble in young calves.

**Milking machines.** The modern milking machine is one of the greatest labor-saving devices ever invented for dairymen. It solves the difficulty of securing efficient help and replaces cheap labor with skilled. It is now considered a part of the necessary equipment of all large dairies, and it has been an important factor in the development of the dairying industry. It has been developed to a degree that makes its use entirely practicable in dairies having more than 10 cows. There is, however, still room for improvement. It has no harmful effect on the physical condition of the cow; and, as regards quality and quantity of milk, its use competes successfully with hand milking. It is of great importance that the rubber parts and all parts which come in contact with the milk be thoroughly cleansed after using.

All milking machines are somewhat complicated and require the exercise of mechanical ability on the part of the operator. Like other mechanical devices, they require intelligent supervision in order to secure the best results. The milking machine must be operated and adjusted to meet the needs of the individual cow, and its success or failure depends upon the ability of the operator.

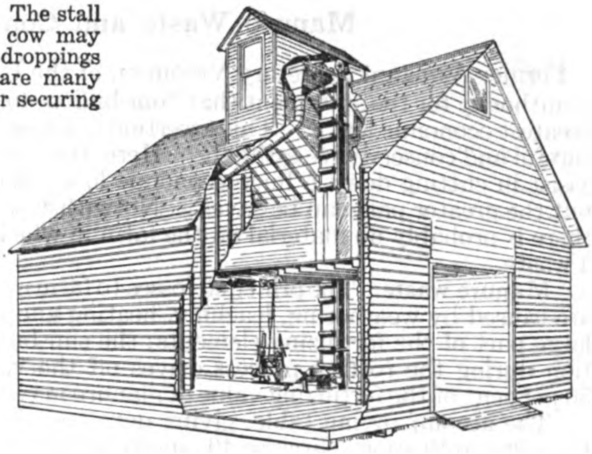


FIG. 551. Granary partly cut away to show grain elevator in place. The movable chute may be directed into different bins. There is usually a trap door and dumping arrangement by which wagons can be unloaded into a bin from which the buckets elevate the grain.

**Grain elevators.** The grain elevator (Fig. 551) is another machine which has effected a great saving of labor, especially during harvest. It is meeting with much favor in the Middle West, where large quantities of grain are stored in barns and granaries. It may be used for all kinds of small grain and for ear corn. Two general types are employed: the portable elevator on the outside of the barn, and the stationary elevator inside, with some form of a dumping device. Both types are widely used, and selection is determined by local conditions. However, when erecting a new set of buildings, provision is usually made for the stationary type. The elevator may be run either by horsepower or by motor. The most popular type of farm elevator is composed of a series of buckets or cups fastened to an endless chain running over a set of parallel shafts and pulleys.

Among the numerous other labor-saving devices which materially help to increase the efficiency of the barn, but which need only be mentioned are: Sliding doors with birdproof tracks and roller-bearing hangers, making door operation easy and obviating noisy and broken hinges; hay-carrier returns and pulley-changing devices; overhead feed bins with hopper bottoms; hay chutes; platform scales and spring balances; elevators for silo chutes, etc.; all of which assist in reducing chore labor on the farm.

| BREEDS, ETC. | SIZE OF COW STALLS | |
|---|---|---|
| | Width | Length |
| Heifers | 2 ft.–9 ins. to 3 ft.–0 ins. | 3 ft.–6 ins. to 4 ft.– 0 ins. |
| Jerseys | 3 ft.–2 ins. to 3 ft.–4 ins. | 4 ft.–6 ins. to 4 ft.– 8 ins. |
| Guernseys. | 3 ft.–4 ins. to 3 ft.–6 ins. | 4 ft.–8 ins. to 4 ft.–10 ins. |
| Shorthorns | 3 ft.–6 ins. to 4 ft.–0 ins. | 5 ft.–0 ins. to 5 ft.– 2 ins. |
| Holsteins | 3 ft.–6 ins. to 4 ft.–0 ins. | 5 ft.–0 ins. to 5 ft.– 6 ins. |

## Manure Waste and Conservation

Former Assistant Secretary Vrooman, of the U. S. Department of Agriculture, is authority for the statement that "our billion-dollar manure waste is the world's greatest economic leak." This assertion is based upon reliable statistics and is a careful and conservative estimate. Here, then, is a place where every farmer can assist in cutting down a huge economic loss. Some of this loss is unavoidable, but the greater part can be saved. Notwithstanding the great value of manure, there is probably no material on the farm in which there is so great and needless a waste.

**Manure waste.** The principal losses to farm manure occur in the barnyard and are caused by weathering, leaching, heating and rotting. The rains wash out a large part of the fertilizing elements; the sun burns out more; and bacterial action during the rotting process drives off the valuable ammonia gases. Fully 50 per cent of the fertilizing value of manure may be lost in this way.

The accompanying table, giving data compiled by the Indiana Agricultural Experiment Station (Circular 49) shows briefly why manure is of such great value as a fertilizer. The chemical analyses were made from many samples from various experiment stations and may be said to be truly representative.

QUANTITY, COMPOSITION, AND VALUE OF MANURE FROM DIFFERENT CLASSES OF ANIMALS

| | HORSE | DAIRY COWS | STEER | SHEEP | SWINE |
|---|---|---|---|---|---|
| Pounds of manure produced per day per 1,000 pounds live weight | 35—45 | 70—80 | 40—50 | 30—40 | 40—50 |
| Pounds per ton nitrogen | 11.8 | 9.7 | 13.8 | 27.5 | 15.2 |
| Phosphoric acid | 5.6 | 5.4 | 5.6 | 9.9 | 9.5 |
| Potash | 14.6 | 9.4 | 10.5 | 22.7 | 14.6 |
| Value per ton on basis of analysis* | $ 2.84 | $ 2.21 | $ 2.90 | $ 5.83 | $ 3.49 |
| Tons of manure produced per year per 1,000 pounds live weight | 7.0 | 12.7 | 7.5 | 5.5 | 7.3 |
| Value of manure produced per year per 1,000 pounds live weight* | $19.88 | $28.07 | $21.75 | $32.06 | $25.48 |

*Computed on the basis of the following prices: Nitrogen, 15 cents per pound; Phosphoric acid, 3½ cents per pound; potassium, 6 cents per pound.

Manure represents fertility which has been drawn from the soil by crops. Nearly 80 per cent of the fertilizing value of crops can be returned to the soil in the manure. The manure which is returned to the soil not only serves to cut down the drain on it, but also helps it in many other ways. It increases the supply of humus, adds plant food, and makes other plant food in the soil available, besides aiding in the development of soil bacteria. It also helps the soil to warm up earlier in the spring, decreases soil washing, improves the drainage, and enables the soil to receive and retain more moisture for the growing crops. It is reported by the experiment station at Rothamsted, England, that the residual effects of manure can be noticed for 40 years after application upon land that has been continuously cropped.

**Conservation of manure.** Manure begins to deteriorate the very hour it is dropped. The sooner it reaches the field, the better. Tight floors are valuable agents in the saving of manure, and a good concrete one in the barn will soon pay for itself in the saving of fertilizer elements.

A manure spreader is the best and most economical method of applying manure to the soil. As a farm implement, it is second

in importance to the self-binder only. It is always ready for its part. It distributes the manure more easily and evenly and renders possible the spreading of specific quantities.

While the direct-to-the-field method is preferable, it often happens that this is not convenient or possible. Bad weather and busy seasons sometimes interfere. A manure pit should, therefore, be provided, to hold the excess manure formed during such periods.

If we allow manure to stand in a heap, we shall find it divided into 3 layers: the fresh manure on the top, the rotted manure in the middle, and at the bottom decomposed manure with a very offensive smell. The latter has lost a large part of its fertilizing elements, and is not in a condition to give best results.

The bacterial actions which go on in a heap of manure are caused by two kinds of bacteria—aërobic, which live in the presence of air, and anaërobic, which can live without the presence of air. The manure pit should be deep enough to permit both kinds of bacterial action, and not too deep to prevent them. For this reason, a manure pit should not exceed 3 or 4 feet in depth.

Manure in a pit should be spread uniformly, kept moist, and well packed. The wetting down can be easily accomplished by using a pump, preferably one of the diaphragm type. The bottom of the pit should drain to one place, so that the liquid which has separated out may be pumped back over the manure.

Since manure is very low in phosphorus, acid phosphate is sometimes mixed with the manure in the pit, at the rate of 1 pound per day per head. This helps to increase the fertilizing value of the manure, and prevents the breeding of flies.

**How to construct a manure pit.** In constructing a manure pit, the following requirements should be kept in mind: (1) it should be permanent and water-tight (for this purpose, concrete is an admirable material); (2) all corners should be rounded, so that the manure will pack well; (3) it must not be built too deep to prevent bacterial action; (4) surface water must be kept out of the pit; and (5) the driveways in and out of the pit must not be too steep.

The size of the manure pit will depend upon the length of time the manure is to be kept in storage. Manure should not be stored longer than 8 or 10 weeks, as in that time bacterial action is carried too far. It is preferable to empty the pit every 2 or 3 weeks.

A pit 12 by 12 by 4 feet deep will provide

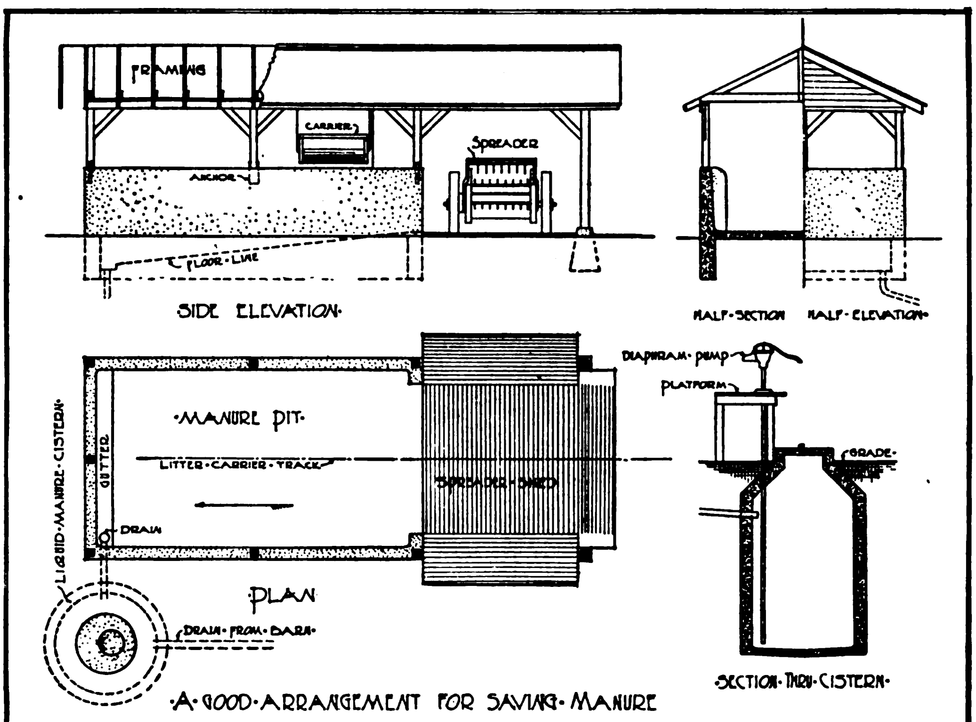



FIG. 552. Plans of a manure pit and liquid manure cistern by means of which all the plant food may be saved and the manure kept in the best possible condition

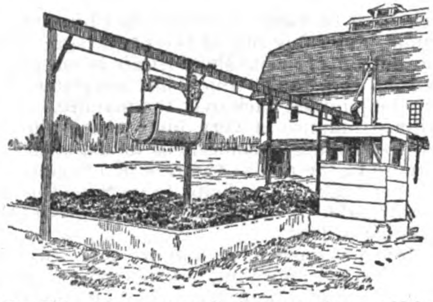


FIG. 553. A manure carrier is a great time- and labor-saver. This is a simpler structure than is shown in Fig. 552, but wouldn't you prefer using it to—

storage space for manure from 100 head of cows for 2 weeks.

Every particle of liquid manure should be saved, as with all farm animals 43 per cent of the nitrogen and 60 per cent of the potassium passes off in the urine. The liquid-manure loss constitutes by far the greatest waste of manurial elements on the farm. The annual potassium loss in the United States in liquid manure is alone more than a million dollars.

A tank or cistern to hold the liquid manure should be provided, and this should be below the level where the animals stand, so that the urine may drain into it. In warm weather, this tank should be emptied every 3 or 4 weeks, and kept tightly covered, to prevent the escape of ammonia gases and consequent loss of valuable manurial elements. A cow will pass daily 15 to 20 pounds of urine; a horse, 8 to 12 pounds. This data may be used in determining the proper size of cistern or tank to build. A round tank, necking at the top like a cistern, is the best, as it has a smaller surface for evaporation.

FIG. 554.—Doing this every day?

## Lighting

During the winter season most of the barn chores are done with the aid of some form of artificial light; and this is particularly the case on the dairy farm, where such light is required most of the year. A good lighting system in the barn is a paying investment: it means that the chores can be done much easier and better, and with the least expenditure of time and labor.

The old-style kerosene lantern is still quite commonly used, regardless of the fact that the carrying of a lighted oil lantern in a barn among highly inflammable material is a very dangerous practice. It will be remembered that Mrs. O'Leary's cow kicked over a lighted lantern in a barn and caused the great Chicago fire; and similar accidents may happen in any barn where the old-style lantern is used. An enormous fire loss on farms is caused every year by the careless use of lanterns. When a lantern is overturned, the oil it contains adds fuel to the conflagration; and a fire once started in a barn usually burns itself out.

If it is necessary to use a lantern of any kind, some form of electric lantern should be procured. The electric lantern is more convenient to use, does not blow out in the wind, and is entirely safe. It works on the same principle as the electric flash light. It consists of a small electric bulb, with a suitable reflector, and derives electricity from dry cells. Although there is still room for improvement in them, electric lanterns have reached such a state of development as to make their use entirely practicable on the farm.

**Acetylene gas and electric light.** Two other sources of light are available for the barn, and these far surpass any portable light. They are acetylene gas and electricity.

Acetylene lights can now be obtained with the flame properly protected and with electrical igniting devices which make them safe for use in the stable. They are not, however, to be recommended for use in the hay mow.

Just as electric lights have replaced the kerosene lamp in the city home, they will eventually replace the dangerous kerosene lantern in the barn. The electric light is the one which strongly appeals to the farmer.

A statement was recently made by a well-known cattle breeder that electric light in his barn had paid for itself in one night. By having a good light he was able to save a valuable animal which was sick, whereas, if it had been necessary to depend on a lantern, he would have lost it.

Usually, electric lights in the barn are easily provided for, since a gas engine is commonly needed to pump water or run a

feed grinder. It is very convenient to have electric light, as a wire may be run to any place where a light is needed. When lights are placed in feed and litter alleys, they materially cut down the time and labor required to do the chores. They are also convenient and safe to use in the hay mow; for they may be placed up out of the way, and they will furnish a good light in the mow.

When a building is wired for electricity, only such material and fittings should be permitted as will meet the required electrical standards. Switches should be provided at convenient places, so that the lights may be easily turned on and off. This is one of the advantages of electric lights because a three-way switch may be used on the line between the house and the barn, which will enable the lights to be turned on at the barn and off at the house. This is a great convenience in case it is necessary to go out in the night to attend a sick animal or to investigate disturbances in the barnyard. The electric light is always in its place, and it is not necessary to stumble around in the dark to hunt for a lantern.

# EQUIPMENT USED IN THE CARE OF LIVE STOCK

*By* C. F. GOBBLE, *Assistant Professor of Animal Husbandry in the Purdue University School of Agriculture, where his several years of teaching have supplemented a wide, practical farm experience.*—EDITOR.

The equipment used in the care of livestock includes a number of the smaller implements which, by the employment of power in their operation become valuable labor-saving appliances. Among these are, for example, the machine sheep shears and machine horse clippers.

While in large sections of the country, these appliances have not yet come into wide use, it is only a question of time when their employment may be expected to become general.

**Sheep-shearing machines.** The necessity of shearing sheep at least once a year has caused the manufacture of several machines for this purpose. Formerly, the work was done with the common hand shears, which are quite like a pair of scissors, except that the power is applied between the fulcrum and the blades, and the blades spring open when the pressure is removed.

These shears are cheap, do the work in a satisfactory manner in the hands of a skilled workman, and are indispensable on any farm where sheep are raised, for trimming and tagging the flock. For shearing, however, they are being gradually replaced in most sections of the United States by machine shears. With these, less skill is required, the work is done more quickly and easily, fewer cuts are made in the skin, and more wool is obtained, because it is cut more closely. The machine shears are, of course, more expensive, but this is soon offset by the saving of time and wool.

The power for these machines is supplied by hand, belt, shaft, or motor. The hand machine used by the small sheep-owner is light, compact, durable, and easily operated and adjusted. One boy or man is required to furnish the power in addition to the one handling the shears. The cutter head works on the principle of the sickle on a mowing machine, the important parts being the cutter and the comb. The comb, made up of several long teeth with sharpened edges, passes through the wool at the surface of the skin, dividing it into small bunches for the cutter, which is ordinarily made up of 3 teeth with sharpened edges. The cutter, oscillating at a high rate of speed over the surface of the comb, shears the wool almost as fast as the cutter head can be passed over the body of the sheep. As long as the comb is held flat on the surface of the skin, the wool will be sheared close to the body without danger of cutting the skin, as the teeth in the comb are much longer than those of the cutter and act as a guard. The power is transmitted through a flexible shaft.

Formerly, the chief objection to this machine was the difficulty in getting the cutters and combs sharpened. This has been largely overcome by the manufacture of a grinder, which consists of a revolving disc run by crank and gears.

With the other power machines, the cutter head and flexible shaft are the same as in the hand machine, the point of difference being in the source of the power. These machines are of necessity more expensive, and, therefore, are practicable only where large numbers of sheep are to be shorn, as on the Western ranges. The power may be derived from a steam or gasoline engine by belt or shaft or from an electric motor.

**Horse-clipping machines.** Clippers are used to remove the horse's winter coat after the weather turns warm in the spring; to trim the hair on the udder, flank, and thighs of dairy cows in milk; and to shorten the hair on the head, tail, and legs of some beef animals in preparation for show.

A clipper, similar in type to that used by

barbers, but larger, is used by some stockmen. The large hand clipper which is operated by both hands is, however, employed more extensively than the lighter type. These are satisfactory for small jobs, but where the whole animal is to be clipped, or several are to be trimmed, the time necessary for such an operation renders such hand tools impracticable. To meet this condition, machines are being manufactured that are very similar to the sheep-shearing machines, except that the teeth in the cutter head are much shorter and more numerous, and that the power is transmitted through a chain which turns in a flexible tube. The chain in the tube gives to the machine more flexibility than the flexible shaft, and works satisfactorily, since less power is required to cut hair than to cut wool.

The power for these machines may be applied in exactly the same manner as for sheep-shearing machines. In fact, the horse-clipping attachments may be used on the sheep-shearing machine, or the sheep-shearing attachment on the horse-clipping machine, thus making it possible for the farmer to add either one or the other at a small additional cost.

**Power dental float.** This is an attachment to the above clipping machine. The disc file, rotating at high speed, quickly files the teeth to the desired length. Such an instrument is desirable where enough horses are kept to warrant the purchase of a clipping machine.

**Grooming machines.** The motor brush is a cylindrical brush attached to a flexible shaft, which, when rotating at a moderate rate of speed, makes it possible for one man to groom several horses in a shorter time and with less work than with the common currycomb and brush.

With the vacuum machine a vacuum is maintained in pipes, by which the dirt is drawn out of the hair and conveyed to a receptacle whence it can be removed. Motor brushes and vacuum cleaners have not as yet been very generally adopted, even in large stables.

**Sprayers.** Many farmers fail to recognize the value of disinfectants in keeping lots and barns sanitary. Spraying apparatus is as useful in the care of livestock as of fruit, and the same equipment may be used for both. The tank, or tub, sprayer is probably most useful for the average livestock farm, as it can be operated by one man, and can be easily wheeled in and out of stalls. It consists of a tank, or half-barrel, set on wheels, a pump and agitator, a hose and nozzle.

Poultrymen and small stock farmers might prefer the bucket pump, which can be used with a common bucket and is less expensive.

**Hog oilers.** Patent hog oilers are manufactured on the principles that if a hog has lice he will scratch, and that, if crude oil can be applied to the part that itches, the lice will be eliminated.

There are two general types of oilers—the revolving-drum and the tank-valve. With the former, a solid iron drum is so placed that the under side is immersed in the oil at all times. When the hog rubs against it the drum turns, bringing up a coating of oil which is applied to the hog where most needed. With the latter type, a tank is supported by one or more standards or legs. When the hog rubs against the standard, a valve is opened, which allows small quantities of oil to run down to the point of itching.

There are a number of different makes of oilers on the market that give more or less satisfaction. The experience of users of them seems to indicate that, in general, they help to keep the lice in the herd under control; but they could hardly be expected to clean up a badly infested herd, as it seems some hogs refuse to use the oiler. Trouble, too, has been experienced with some oilers from the valves clogging with mud; and some will be effective with pigs of a certain size, but cannot be used successfully by small pigs. Even with these objections, however, there is no doubt but that a patent oiler would be a profitable addition to the hog equipment on many farms, especially where no dipping vat is available.

**Earmarkers.** There are in use on farms three general methods of marking the ears of purebred livestock: (1) the ear label, or tag; (2) the notch; and (3) the tattoo mark. All are used to a greater or less extent. Sheepmen ordinarily use the metal-ribbon label; hogmen use the ribbon, the button, the tag, and the notch; the notch being used almost universally in marking litters. The tattoo is used more by cattlemen than by other breeders, although the metal-ribbon label is also extensively used by them.

The metal ribbon requires the use of a punch, similar to a leather punch, which cuts an oval hole through the ear, to allow the

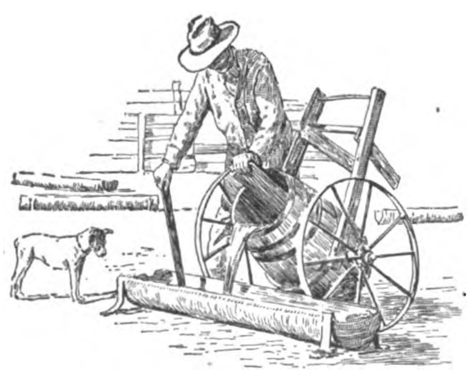


FIG. 555. Feeding is a task that must be done at least twice daily, the year 'round; every possible method of lightening it is worth trying. This wheeled, slop barrel makes hog feeding considerably easier than it would otherwise be.

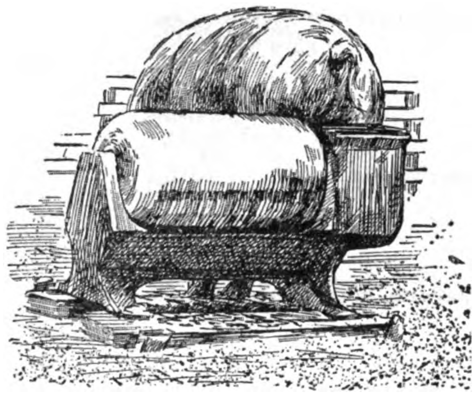


FIG. 556. By making stock take care of itself we save both time and money. Oilers keep hogs free from parasites and thus contribute to their comfort, health and increased growth.

insertion of the label. The hole for the button is made in the same way, with the exception that it is round and smaller. The tags are fastened to the ear with a common hog ring. The tattoo requires a special marker, which consists of a pair of pincers with one jaw made to accommodate a set of removable letters and numbers. The letters and numbers are made of steel points which, under pressure of the pincers, penetrate the skin of the ear and allow the deposit of sufficient tattoo oil to mark the ear permanently.

**Teeth nippers.** In order to eliminate sore mouths and sore teats, caused by the long, sharp teeth of young pigs, two types of nippers are in use. One is simply a small pair of pliers that break off the sharp points; the other is supplied with sharp edges which cut the teeth off at the desired length.

**Dehorning instruments.** There are two general methods for dehorning mature cattle; namely, by the use of the saw and by the use of the knife. The most improved knife has two blades ground with concave-angle cutting surfaces which form two opposing shears and thus give equal pressure from 4 directions. The power is furnished by the 2 handles having corresponding eccentric gears that work in the teeth of a tapering rack attached to the movable blade. When the handles are brought together, the power of their combined leverage is transmitted through the rack to the sliding knife, which, working against the stationary knife, shears off the horn. This dehorner has the advantage of doing the work with more speed; but it is more expensive than the saw, which, for the small stockman, will give satisfactory results.

**Sheep-docking irons.** Lambs are docked when 1 or 2 weeks old, in order that they may be kept clean around the hind quarters and that the ewes may be more easily bred. A sharp knife or chisel and a mallet will do the work, but the accompanying loss of blood has caused many shepherds to adopt one or other of the types of docking irons. These irons, being hot, sear the cut surface of the tail and eliminate the loss of blood, thus lessening the danger of losing some of the lambs.

There are two general types of docking irons—one very similar to the common chisel, and the other constructed on the plan of hoof parers used by blacksmiths. Both types have heavy jaws and blunt cutting edges. Neither is expensive.

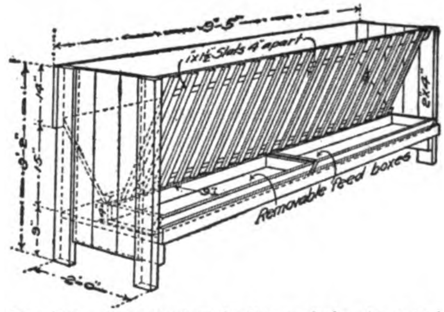
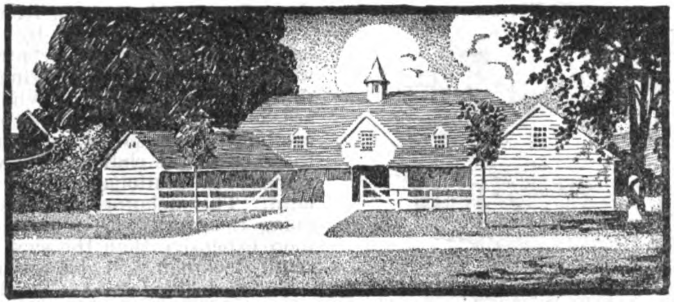



FIG. 557. A convenient feeding rack for sheep to be used either in the barn, the feed lot or on pasture. The grain boxes being removable are more easily kept clean.



# CHAPTER 34

## Special-Purpose Barns

*By* JOHN M. EVVARD, *Associate Professor and Assistant Chief in Animal Husbandry, and Chief in Swine Production, Iowa State College, who was born on a farm in Livingston County, Illinois, and received his agricultural education there and at the universities of Illinois and Missouri. For three years he was Assistant to the Dean of the College of Agriculture of the University of Missouri, having charge of the animal husbandry problems in nutrition. In 1910, after a year of travel through the Middle West studying farm and livestock conditions, he joined the staff of the Iowa College, where he has since carried on his investigational and instructional work in livestock production. Both his training and his work have therefore made him especially able to discuss the principles underlying the construction of the farm buildings that have as their special task, the housing of farm animals.*—EDITOR.

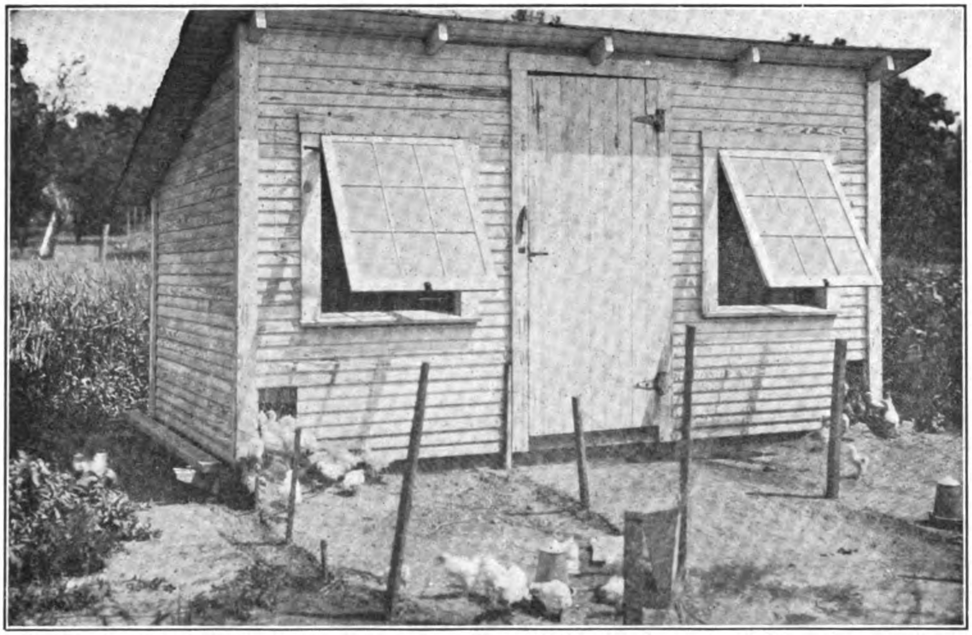
IN THE planning and building of special-purpose barns, one should keep clearly in mind two main considerations. The first is the particular kind of livestock to be housed, for each should be sheltered so that it may do its work to the best advantage. This means that the barn must be planned from the inside out, and not from the outside in. The second is the convenience and preference of the livestock man himself, important factors being the saving of labor, low relative cost, pleasing appearance, etc. Of course the local conditions and requirements must be met in a practical manner. This means that there must be many averages struck, until the final result meets all needs as nearly as possible.

We must bear clearly in mind the use or function of the kind of livestock housed. Dairy cows, for instance, produce milk for human food, the finished product being drawn from the animal machine right in the barn. In the case of a pig or a steer it is different; we build up a machine and then we eat it, and the product is not gathered right in the barn but must be slaughtered and prepared either on the farm or in a packing house. The brood sow, or cow or mare performs still another function—that of producing young for future usefulness. With sheep, the wool is the product and must be kept clean; moreover labor is required in putting it in shape for use. Finally, the horse may be kept solely for work. All these differences mean the building of vastly different structures; but there are, nevertheless, some general considerations which are essential for all classes of live stock. Though in some instances these have already been mentioned in earlier chapters, they may well be reviewed here.

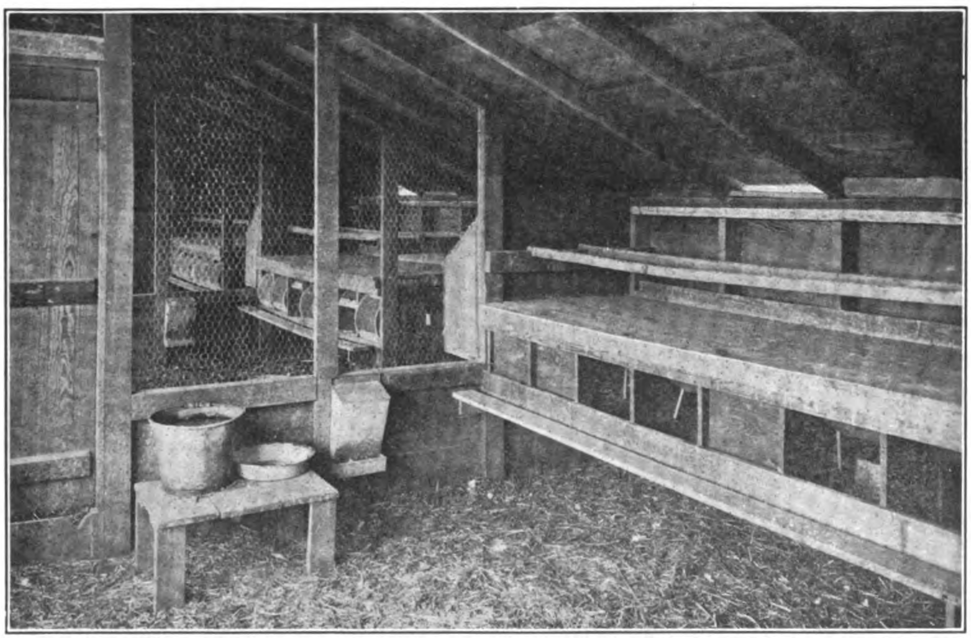
Ice harvesting offers an unexcelled opportunity for successful and profitable community co-operation

But each individual farm should have its ice house, and, if possible, a cold storage building adjoining it

THE FARMER'S FUEL IS IN HIS WOODLOT; A SUPPLY OF ICE IS HIS FOR THE TAKING. WHAT OTHER PROFESSION OFFERS SUCH PERQUISITES IN ADDITION TO ITS NORMAL RETURNS?



A portable farm brooder house that can be changed into a colony house as the birds outgrow the need of artificial heat



Inside a well-built, well-arranged poultry house of the long or commercial type. Note roosts, droppings platform, nest boxes and elevated feed hopper and drinking vessels

CAREFUL HOUSING OF POULTRY PAYS. BECAUSE A FLOCK SURVIVES NEGLECT IS NO REASON WHY IT SHOULD NOT BE GIVEN CONDITIONS UNDER WHICH IT CAN THRIVE

## The Main Considerations

1. **Protection from severe cold and heavy winds.** Animals can stand still cold much better than cold winds, but buildings reinforced by windbreaks furnish sufficient protection from both. This, of course, includes protection from exceptionally heavy storms, such as tornadoes, or driving hail which ofttimes plays havoc with live stock.

2. Correct temperature. This does not mean ordinary room temperature for human beings around 68 to 70 degrees. Heavily wooled sheep, for instance, are perfectly well off in freezing weather, even with the temperature around zero Fahrenheit. They can largely regulate their own temperature if given correct feeds, and they do much better so than if housed in a warm barn. The fattening steer with heavy covering of fat, hide and coat, does splendidly in snappy, bracing weather around 20 to 30 degrees F., better indeed, than in the very hot summer months.

The hog on the other hand needs protection and must be warmly housed. An average temperature of 68 to 70 degrees, though not always possible, is not far wrong for a growing pig. Fattening hogs stand quite cold weather but they, too, should have a tight house and a nice warm bed. The horse driven continuously throughout the winter should have a fairly warm place, or else be carefully blanketed after every drive. "Stocker" colts and horses running in the field can stand much cold; however, on real cold days all horses should be amply protected.

But there is one class of all kinds of farm animals that needs considerable warmth, namely the new-born ones. In the case of lambs, colts and calves, this is true for only a short time; little pigs, on the other hand, need much protection for many weeks after farrowing.

Warmth is mainly secured by tight walls and roofs; plenty of windows to admit sunshine; low ceilings (especially for pigs and sheep); and artificial heating.

3. Dryness. The amount of wet that our domestic animals can stand, particularly beef cattle and horses, is remarkable yet they gallantly respond to a good dry building. A dry, solid, slightly sloping floor which does not attract moisture is in order, to make possible a dry bed.

To make a building dry, it is essential that the roof and walls be tight, the doors well hung and properly framed; the windows correctly jointed with whole panes of glass and frames snug. The roof is all the better if sheathing is placed underneath. Sliding doors are usually more convenient than swinging doors, but they have the drawback of not being easily made tight against rain, drafts and drifted snow.

The condensation of water which sometimes occurs on the under roof of buildings is undesirable for live stock, keeping the air damp and the bedding wet, and sometimes dripping on the animals' backs. A metal roof quickly causes condensation because, when the moisture-laden air rising from the animals hits the cold roof, it contracts in cooling and the moisture is quickly deposited. Inasmuch as the animals constantly give off moisture through their lungs, the surface of their bodies, and their excreta, proper ventilating devices are essential to prevent its accumulation.

4. Ample drainage. Good drainage is essential to health; and the slope should always be away from the building. Many open sheds shelter stagnant pools or mud wallows where disease germs multiply, and which should be prevented by drainage. Both surface and underdrainage should be looked to. Briefly, therefore, the drainage should be from the inside out, and then from the outside away to some distant point. Of course the outlets must first of all be planned for.

5. Abundance of light. The saying "Darkness breeds disaster" has much truth in it. Light paves the way to an inspiration to clean

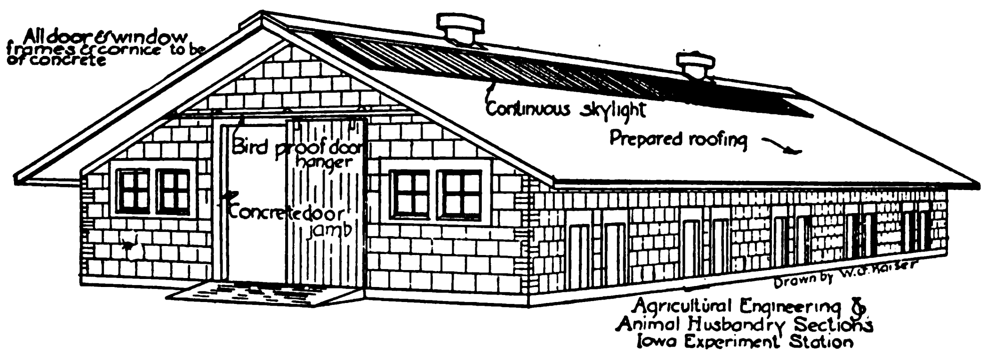



FIG. 558. Buildings for livestock should protect from the weather, and provide drainage, ventilation, dryness and sunlight. The Iowa Community Sunlight hog house is a strikingly successful structure in all these respects.

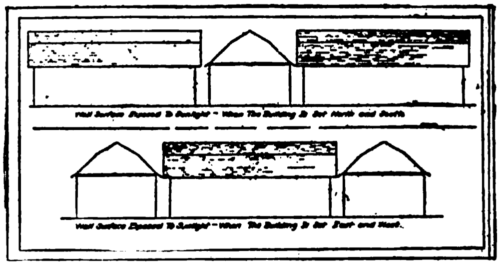


FIG. 559. Showing how a building placed north and south (*above*) receives more light along its sides where the most windows are, than one set east and west (*below*.)

up; darkness offers no incentive because it does not disclose what is needed. Dark stables are dangerous to man as well as beast, for horses are more liable to kick in the dark, and mules also are more unruly.

Light, even diffused light, is a great germ destroyer, and our modern barns are like our modern factories, being exceptionally well lighted with the windows properly placed so as to admit maximum daylight. White walls are becoming more and more popular because with them we can almost double the amount of light; solid partitions are being discarded because they darken the stables and barns and are unsanitary; other schemes are being used to advantage such as splayed windows, skylights, light-colored (concrete) floors, etc.

6. **Direct sunlight** is coming into its own as a universal germ and disease destroyer, costing practically nothing and always available if the right opportunity is presented. It promotes dryness, warmth, ventilation, diffuse lighting, sanitation, and drainage. It instills general vigor, muscular strength, high vitality, and good color in the animals. Young animals respond favorably to light as do plants. Perhaps not so vividly so far as color is concerned, but certainly so as regards growth and development. The forenoon sunlight is particularly important with livestock; after a relatively long, dark and perhaps cool and damp night, it is of great value as a morning bracer or reviver.

In securing direct sunlight, buildings built east and west are not nearly so favored as those built north and south. The southern exposure is always eagerly sought for cattle yards, sheep corrals, pig pens, and horse yards.

7. **Shade.** Protection from the sun's direct rays is necessary all the year 'round. Too much sunshine is not best, nor is too much shade; we must, therefore, strike the happy medium. Proper shade has that cooling effect which is essential. There is a restful feeling in it as contrasted with the open, bright rays of the sun. Considerable load is taken from the nervous system when it is provided. Furthermore it keeps the flies partially controlled.

8. **Abundant ventilation.** All animals demand an abundance of fresh, pure air. They are continuously giving off moisture and carbon dioxide, a poisonous gas. This means that the barn air is steadily becoming laden with products that are unhealthful. The essential thing, therefore, is to supply a circulation of fresh air without drafts in such a way as to remove the foul air and not interfere with the comfort of the animals.

The air change required by animals is variously estimated, but it is generally conceded that the air should change at least 3 and upwards to 6 times or more an hour for best optimum results. The average amount of air inspired and exhaled per hour is estimated for mature animals approximately as follows:

| | |
|---|---|
| Horse . . . | 100 to 200 cubic feet, an average of 150 |
| Cow . . . | 80 to 160 cubic feet, an average of 120 |
| Swine . . . | 40 to 100 cubic feet, an average of 70 |
| Sheep . . . | 20 to 50 cubic feet, an average of 25 |

This does not mean that this much air has to be provided every hour, but it does mean that this much air passes into and out of the lungs in that period.

Estimates as to the amount of fresh air which should be allowed the different animals per hour and the cubic feet of barn air space they should be allowed, are as follows (although accurate experimental evidence to give them weight is lacking):

| MATURE ANIMAL | CU. FT. FRESH AIR PER HOUR | CU. FT. SPACE IN BARN |
|---|---|---|
| Horse . . . | 4,000 | 900 |
| Cow . . . . | 3,000 | 700 |
| Hog . . . . | 1,500 | 250 |
| Sheep . . . | 800 | 150 |

Ventilation can not be secured to great advantage without system, hence there have been developed two great ventilating systems, the King and Rutherford, both exceptionally

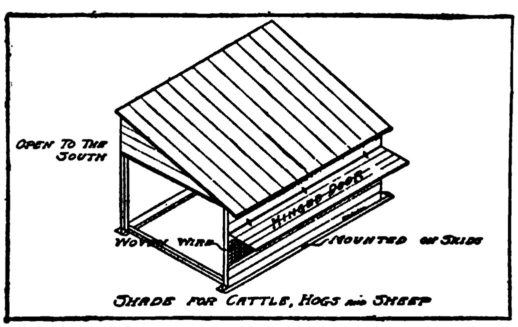



FIG. 560. The low cost of a movable shelter like this is repaid many times over in the added comfort of the stock

good. The former is particularly popular in the Middle West, and the latter in the northern, colder climates where it is said to work to good advantage. (See Chapter 33.)

Some schemes for securing ventilation—schemes which do not interfere with the safety and comfort of the animals—are based on (a) the use of cupolas which have upwardly slanting slats which tend to pull the current of air upward, deflecting it from the barn proper (a screen over it tends to keep birds out of the hay mow and barn proper); (b) the use of windows hinged at the bottom and swinging inward from the top are useful as are also the ordinary windows; (c) the use of double doors, the upper and lower half of which can be closed separately are used widely; (d) the King and Rutherford ventilating systems which provide means for the air to enter as well as to escape from the building, the general principle under which they work being that warm air is lighter than cold air.

Livestock, whether work animals such as the horse or the ox, fattening animals such as the hog and steer, milk-producing animals such as the dairy cow, and goat, or breeding females, cannot do their best without an abundance of fresh air—air that is continuously and gently circulating over their bodies.

9. **Sanitation.** We are living in a sanitary age because we now appreciare what sanitation means; this is nothing more nor less than keeping things healthy through the elimination of disease germs when they gain access, but primarily the prevention of their getting a foothold or even gaining an entrance.

Cleanliness is highly important, and a building, to be kept clean, must be free and accessible to the broom, the spray, and the pitchfork. To this end walls, roofs, and floors should be tight and smooth.

Dust, which carries countless millions of bacteria including many disease-producing ones, should be so far as possible prevented. In the dairy barn, for instance, dust from the hay mow is undesirable; to prevent it tongued and grooved lumber should be used between the floors, and the hay should be brought down through hay chutes, carefully screened off from the barn proper.

The prompt removal of litter is highly important. The easier this can be done the more likely it is to be done properly, completely and quickly. The litter carrier (p. 392) smooth floors, and a handy stall arrangement are of considerable help. Let us forget that some animals, such as the pig, live and therefore breathe, eat, drink and sleep close to the ground. For this reason if for no other, the floors, and the yards, stalls, and pens in which livestock are kept should be carefully kept clean of objectionable material.

10. **Safety.** The modern slogan "Safety First," is of particular importance in connection with correct livestock housing. It is not uncommon nowadays for a man to own a

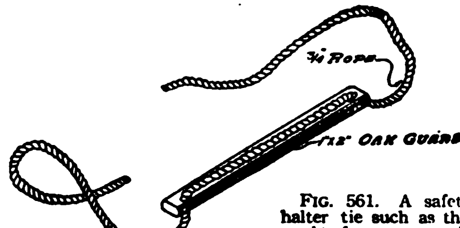



FIG. 561. A safety halter tie such as this used to fasten mares will prevent the loss of many a foal that might otherwise get the rope around its neck and be strangled to death.

dairy cow worth $1,000 or a beef bull, worth $2,000 or herd boar worth $1,200 to $1,500. Such high capitalization makes it necessary that we provide for the safety of the animals, by protecting them from mechanical injury and disease. Fenders that save the little pigs, safety doors that cannot strangle or injure animals; proper placing of manger and halter ties; large box stalls, and countless other details help bring about this result.

Here are some features which need special consideration: Avoid *low doorways*, and narrow ones, if too low horses may bump their heads and develop poll-evil; if they are narrow, horses and cattle may knock down their hips. Avoid *high sills*, particularly in brood sow pens, because the mere dragging of their bodies over these sills while the sows are heavily pregnant may result in dead pigs at farrowing time. Avoid *"slick," slippery floors*, particularly in dairy barns, or we may expect animals to be injured by seriously spreading their legs. Avoid *unstable construction* that results in barns being blown down when heavy winds come, ventilators, windows, and doors that easily jar loose, etc. Avoid weak or damaged and unrepaired partitions; stallions have been ruined by getting their feet through such partitions and breaking their legs; hogs and sheep have strangled themselves in dangerous partly boarded places of this sort. Avoid *"chuck" holes* in the floor which are a source of constant danger to sucking pigs. Avoid *steep, treacherous inclines*, particularly those unequipped with side rails or walls, and proper cleats; many a horse has been made unsound through carelessness in this connection. Avoid low mangers into which horses and cattle can jump; make such structures of just the right height for the animals that are to use them. Avoid sheep barns that can not be fenced and closed tightly against dogs or other enemies. There are hundreds of such little details that must be given attention if the greatest possible safety is to be assured.

11. **Comfort.** The ease and contentment of livestock counts for much. The dairy cow is highly sensitive to her surroundings, and must be comfortable, if the milk pail is to be filled. This involves such points as the size

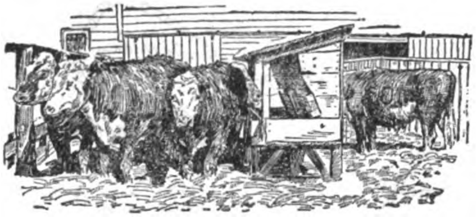


FIG. 562. The comfort of these cattle is increased by the height of the feeding bunk which is built especially to fit them. They would be even better off if in place of the knee-deep mud there was provided a dry, straw-covered concrete pavement.

of the gutter and its distance from the manger; and the height of the manger with respect to the animal it is provided for. Handy stop boards can be placed in the pig pens so as to keep the bedding in a certain corner and thus assist in maintaining a warm, soft bed. Plenty of space should always be provided because crowded animals are not at ease and never crowd naturally except to keep warm. Everything possible should be done to induce livestock, especially dairy cows, fattening animals and hard-worked horses, to lie down and rest. Much more energy is liberated when animals are standing.

12. **Convenience.** What is one man's convenience is another man's inconvenience, and each should plan to suit himself; yet there are some details that are effective aids in all cases. For example, a modern complete watering system saves steps, saves pumping, and the need of constant attention. Handy, well-located feed bins, root cellars, silos, mows and hay chutes simplify work and save time. Feed alleys should be of ample width so placed that the feeding can be done with the least expenditure of time and labor. Work rooms where milk is separated, where tools are handled and repaired, or where harness is kept, should receive attention as to location and arrangement. Feeding boxes and hay racks, if carefully placed, have an important effect in saving exertion. Well-placed doors and windows are easier to open and close, and insure satisfactory ventilation. Litter carriers save time and do their work cleanly with the least hand *labor*, and the same is true of hay and silo carriers. When vehicles are stored in the horse barn, handy exit doors should be provided so that the horse can be attached inside the barn. Offices and general headquarters for the farmstead located in one of the barns, are often a great convenience not only for the livestock husbandman but for the women of the farm as well.

The convenience of the animal should also be considered, particularly if it is self-fed. How much more likely it is to eat generously if the feed is handy and accessible. And how much more likely it is to drink plenty of water if the trough is under cover and handy to the place where it sleeps.

13. **Serviceability.** That barn which is most useful every day in the year is worth a great deal more than the special-purpose barn which can be utilized only at certain seasons or for special functions. The more continuously it is used and the more results it can accomplish, the less costly it is per day of usage. The barns can be so built as to shelter different kinds of animals, or, with slight changes, to provide space for various operations none of which may be important enough or last long enough to justify a building of its own.

14. **Sufficient size.** Overcrowding is poor policy. The barn must, therefore, be large enough to house all the animals, and each stall or pen must be of sufficient size to meet the demands made upon it. Old animals, of course, require more room than young ones, stallions more than mares, and bulls more than cows. In arranging for fat cattle, we must make allowance for the hogs which follow and which are usually an essential adjunct.

As an approximate estimate of the number of square feet of floor surface which should be available for different animals standing and lying, the following figures may be useful:

| KIND AND SIZE OF ANIMAL | SQ. FT. REQUIRED PER HEAD |
|---|---|
| SWINE | |
| 50–100 pounds | 3–4 |
| 100–200 pounds | 3–7 |
| 200–300 pounds | 6–9 |
| 300–400 pounds | 8–11 |
| 400–500 pounds | 10–13 |
| One sow with litter | 40–60 |
| Three or more sows with litters, each | 20–60 |
| Boars, mature, single | 30–50 |
| BEEF CATTLE | |
| Calves and steers: | |
| 75–150 pounds | 7–11 |
| 150–300 pounds | 10–13 |
| 300–500 pounds | 12–16 |
| 500–800 pounds | 14–19 |
| 800–1,100 pounds | 17–24 |
| 1,100–1,400 pounds | 23–35 |
| Breeding cows: | |
| Single box stall | 80–120 |
| Cows with calves | 25–50 |
| Bulls, breeding, box stalls | 100–160 |
| DAIRY CATTLE | |
| Calves, heifers, and steers | Same |
| Breeding cows | Same |
| Bulls, breeding | Same |
| Milking cows alone, stanchions | 15–30 |
| SHEEP | |
| 50–100 pounds | 4–7 |
| 100–150 pounds | 6–8 |
| 150–200 pounds | 7–10 |
| Over 200 pounds | 9–14 |
| Mature bucks | 9–14 |
| Ewes with lambs | 10–14 |
| HORSES | |
| In stalls | 20–50 |
| Brood mares in box stalls with or without colt | 100–160 |
| Stallions in box stalls | 120–200 |
| Young, growing horse stock in open sheds: | |
| 500–800 pounds | 16–25 |
| 800–1,000 pounds | 20–28 |
| 1,000–1,200 pounds | 24–38 |

15. **Durability.** That building which will successfully withstand the effects of rain, snow, and other elements and the wear and tear of actual usage so as to stand up in the best fashion for the greatest number of years, is the most durable. Heavy construction helps toward this end, as do fireproof materials, and paint both increases the length of life and makes a structure more solid.

16. **Storage facilities.** In practically all of our farm buildings some storage space is essential. The hay mow above, to one side, or at the end is ever a pressing consideration; bedding to best serve its purpose must be kept dry and intact; grain bins properly arranged and handily located are necessary; and working equipment nicely covered in some handy place lasts better and is always available.

With the increased use of gasoline and electric power, there is a noticeable tendency to store grain overhead in general livestock barns, although there is a marked tendency to erect single-story buildings for swine and dairy animals. Where power is not available, hay is often stacked up in the central portion of the barn, or else to one side, the main point being that it comes clear to the ground. The general idea is to provide adequate storage conveniently within the barn so long as it does not interfere with the general efficiency from the standpoint of the animals to be housed and of the caretaker who does the work.

17. **Reasonably low first cost.** This should be in line with the kind and amount of service rendered. Extra service may require extra expense, but the value received should always be carefully noted. By keeping down the height of the walls, and by increasing the floor space under a certain roof, we save materials and keep down costs.

18. **Minimum maintenance cost.** The building that costs the least to erect is often the most expensive to maintain, and vice versa. The livestock must pay dividends, and, therefore, must be housed in such a manner as to make this possible.

19. **Pleasing appearance** of the farmstead has already been discussed; the same general principles apply to each building as well as to all of them together.

20. **The ability to meet local conditions.** Many of the points already discussed in this and other chapters have a bearing here, but the importance of the requirement as a whole should be emphasized.

21. **Economy of time** has reference to the owner as well as the livestock; the energy, health and well being of all concerned must be considered. Thus there should be kept in mind: nearness to pasture and shade, convenient arrangement of feed, water, bedding, etc., and such schedules or other plans as will lead to the avoidance of unnecessary steps in doing any work around the building.

## The Housing of Swine

Pigs need protection from severe cold and heavy winds more than most animals: they should be kept in dry quarters because they are very susceptible to rheumatism and kindred ailments; they should have abundance of sunlight, both because it is especially invigorating to young growing pigs and because it cleanses the quarters. In summer they need shade from the very sunlight that is so important in winter. Their houses should be sanitary, for of all animals that carry a heavy risk, swine are the leaders. There should be abundant space, because pigs are inclined to overcrowd, particularly in cold weather. The first cost should be quite low because the average hog is worth much less than the average horse or cow. And because, as noted above, the hog lives close to the ground, it is always subject to infection unless its bed be kept clean, dry and sanitary.

There are two types of hoghouses: the large, centralized, community or stationary house, and the small, individual or movable house.

The community house contains a large number of pens which may or may not have movable partitions, and is a comparatively large, elaborate and durable structure. The individual house has but one pen, is small, simply constructed and comparatively durable. As

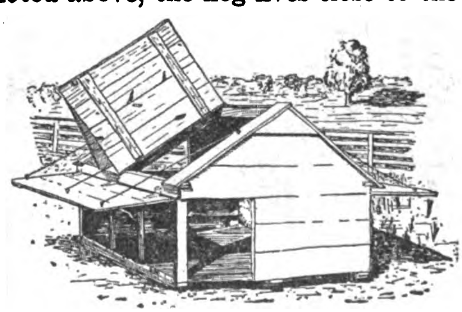


FIG. 563. The Iowa Gable Roof movable hog house with sides and roof sections raised to give maximum ventilation and provide maximum shade for summer conditions.

representatives of these types we may consider the Iowa Community Sunlit House (Fig. 558) and the Iowa Movable House (Fig. 563), both produced and used by the Iowa Experiment Station.

The following general considerations must be borne in mind in settling upon a correct site for the hoghouse, whether it be of the community or of the movable type: (1) Economy of labor and time; (2) sufficient drainage; (3) sunny exposure; (4) southern slope; (5) protective windbreaks; (6) nearness to pasture and summer shade; (7) suitable elevation; (8) prevention of odors reaching dwelling; (9) lessened risk from disease and infection.

## The Community vs. The Movable House

**Advantages** of the community house as compared with the movable type are:

1. Time and labor required may be less, since facilities for feeding and general management may be more conveniently arranged under one roof. The sunning of the quarters can be done without extra work such as lifting the side doors; ventilation is more readily controlled; the stock can be more easily shown to prospective buyers; a horse and wagon are not needed in distributing feed, etc.; there is no moving of houses; and repairs are more simply made.
2. Durability is greater as would be natural with a permanent house.
3. Lighting by direct and diffuse sunlight is more practically arranged because of the greater height and generally larger dimensions.
4. Ventilation may be better because its principles can generally be carried out to better advantage in a large building.
5. The general equipment required is usually less and more compact.
6. Closer attention to the herd is possible.
7. The herdsman suffers less exposure, being always under shelter.
8. Feed storage, water supply, etc., can be more handily arranged.
9. Sanitation is better provided for since concrete and tile construction can be used, and litter removed more easily. Moreover wide bands of sunlight can sweep across the entire interior.

Fig. 564. One of the vital essentials in a hog house is abundant sunlight. The double skylight in the gable roof community house provides it to a highly satisfactory degree.

10. Vermin may be eliminated because of the solid floors. There is often much trouble with rats under movable houses.

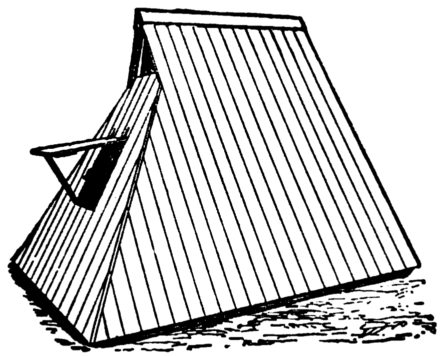


Fig. 565. The tepee type of individual house has the advantages of height in the centre and inclining sides which afford protection to little pigs, but in general it is less popular than either the gable or A-shaped type.

11. Selection of a site is simpler, because only one is needed.
12. May prove more serviceable because a large house can house a greater variety of animals than a small one.
13. Artificial heating is easier because a single stove is needed as compared with a number of heaters for scattered movable houses.
14. One common feeding floor and a common wallow can be used. It is generally impracticable to have a number of wallows for different movable houses.
15. Danger may be less than when there are several houses in one yard, because huddling and piling up will not be so likely to occur in a large, warm, permanent house; pen divisions can easily be arranged.
16. Provides quarters for keeping track of the operations, such as an office.
17. Fire and other risk may be lessened by using masonry construction.
18. Grouped swine become better acquainted than those widely separated.
19. Makes the saving and best use of liquid manure easier.

**20. Advertising value is greater because of its size, permanence and general impressiveness.**

**Disadvantages** of the community, as compared with the movable, house are:

1. Location not easily changed.
2. Isolation of sick animals practically impossible.
3. Sanitation may be made difficult on such ground as: (a) New surroundings can not be chosen at will; (b) rotation of pastures and paddocks not easily accomplished unless the swine are made to walk a considerable distance to the various fields; (c) floors are sometimes damp; (d) dust is likely to be more abundant because so many more animals are present on a small area, etc.
4. Construction is more complicated.
5. Not so practical and economical for beginners or owners of small herds.
6. Much higher first cost.
7. Artificial heat in individual pens not so easily supplied. It is a case of heating the whole house or going to the extra trouble of partitioning off certain portions.
8. More fencing is required to provide similar range and pasture conditions.
9. Greater probability of using it simply as a special-function house particularly for farrowing; this lessens its serviceability.
10. Risk may be greater because the permanent house is usually located near to other buildings where the chance for fire is greater and where lightning is more liable to strike. Hail may damage such a house as the Iowa community with its open windows.

In general, the selection of the type of house should resolve itself into a happy combination of both types, the advantages of one over-

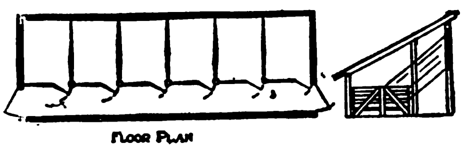



FIG. 566. Plan and section of shed roof community hog house with feeding alley, single row of pens and windows in front.

coming the disadvantages of the other, and both working together for a more harmonious housing system.

## Types of Community House

**The shed roof type** (Fig. 566) which is a very simple structure.

**The half monitor** (Fig. 569) has some advantages as regards sunlight. This type faces the south, the light being secured in both series of pens by a double set of windows.

**The round type** (Fig. 567) is very little used in practice because it is difficultly arranged and the sunshine is hard to secure, neither does it usually fit in well with surrounding buildings, pastures, and paddocks.

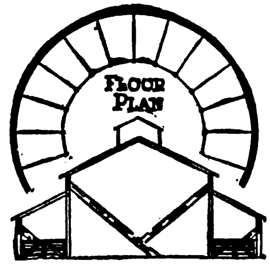



FIG. 567. Partial plan and section of round community type. Unless used for storage the central space is apt to be wasted.

**The modified community gable-roof type** (Fig. 569) which is fairly popular, receives its light from two rows of windows on the same roof side.

**The regular Iowa community sunlight type** (Fig. 568) devised by Professor J. B. Davidson in conjunction with the author, which has a number of advantages including the following: (1) One can build it with a triple row of pens if need be. (2) More sunlight and its better distribution is possible because it comes directly through the roof into the pens and bathes the house thoroughly. Practically every portion is in the direct sunlight during some time of the day (Fig. 568). (3) Low walls are made possible, which is a very important consideration. (4) Hollow-tile construction means extra air spaces within the walls to keep the interior warm. (5) Ventilation is insured by means of the over-head windows which are adjustable, as well as through the ventilators which appear in the roof. (6) The floor may be built of tile, thus providing an air space between the layers of concrete. In the central feeding alley, ordinary solid cement can be used because the hogs do not ordinarily

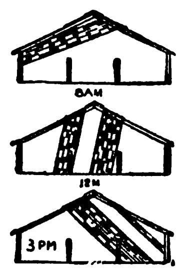



FIG. 568. Section of Iowa Sunlight type house at three hours of a March day, showing how the skylights permit bands of sunshine to sweep clear across the building.

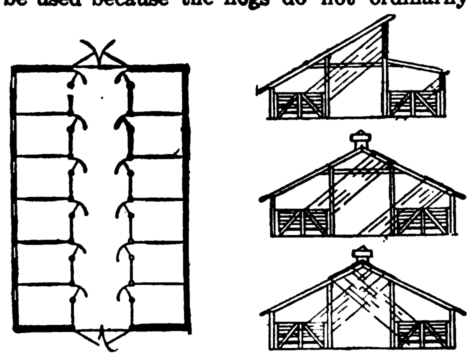


FIG. 569. Sections and floor plan (which is the same for all) of the Half Monitor (*top*), Modified Gable (*centre*) and Iowa Sunlight types of community house, showing comparative amounts of light received.

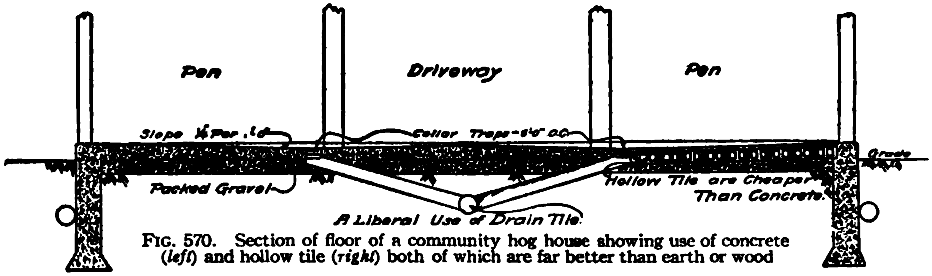



FIG. 570. Section of floor of a community hog house showing use of concrete (*left*) and hollow tile (*right*) both of which are far better than earth or wood

have to lie there. In the building of a combination concrete and tile floor, a simple, somewhat heavy layer of concrete is put upon a firm foundation, after which the rectangular clay tile are put in and covered with a second layer of concrete. Round tile may be used but not so advantageously.

### The Movable House

A good type of movable house is the Iowa gable-roof (Fig. 571). As compared with the A-type (Fig. 572), it (a) provides more open space with the same floor area; (b) gives more vertical space for self-feeders and other equipment; (c) makes shade doors possible; (d) provides for easy ventilation both summer and winter by means of exits underneath the peak ends of the roof, as well as the windows and doors; and (e) is easier to move because a rope can be hitched around the upright side

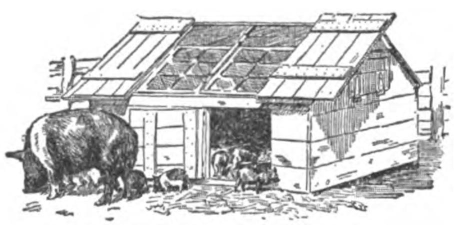


FIG. 571. The Iowa gable roof movable house in winter. Glass sash in the roof keeps the interior dry, bright and warm.

wall more easily than around the slanting sides of the A house.

The greatest virtues of the A-type are: (a) It provides its own fenders in its slanting

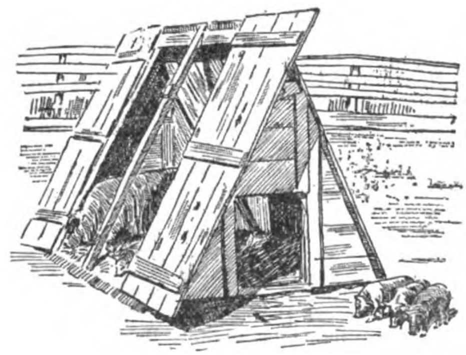


FIG. 572. The A-type is the simplest of all hog houses. The hinged side makes cleaning easy but reduces the protection afforded in wet, stormy weather.

side walls (But in providing these fenders much room is lost). (b) It is cheap to build although not much more so than the gable-roof house, everything considered. (c) It is very easy to build, and easy to care for, especially if made with a door in the side wall.

The swine farm that raises sufficient hogs to justify the use of both community and movable hog houses, is particularly fortunate.

## The Housing of Dairy Cattle

The dairy cow is essentially a machine, the raw materials it uses entering, the refuse being discarded, and the finished product being produced within, the very structure that houses the machine. We must therefore provide a barn that is suitable as a manufacturing place for a perishable and easily contaminated product, as well as a comfortable home for the animals.

On this basis, some of the main considerations in building a dairy cow barn are:

**1. Sanitary features.** The walls should be smooth and substantial and the floors solid. In the mangers there should be partitions between each two cows, and gutters should be provided to drain away the liquid manure and to catch the solid excrement. The floors should be kept clean and dry, and made of materials that contribute to this end. Odors should be kept down by providing adequate drainage. Whitewash may be used liberally both to make things sanitary and to improve the lighting.

**2. An abundance of light and as much direct sunlight as is reasonable.** One square foot of flat glass surface to 20 to 25 feet of floor surface is one allowance; another is 4 square feet to the cow. The whole interior should be as open as possible.

**3. Safety and comfort.** This means that stalls of the proper dimensions should be provided as well as careful methods of fastening the animals within. Slippery floors must be avoided and the cows should not be made to lie on damp, wet concrete but preferably on creosoted wood or cork platform blocks.

**4. Ventilation demands special emphasis.** Two general schemes of ventilation are used, one admitting the air at the middle of the barn over the alley, and taking it out near the floor at the side walls. The other admits the fresh air at the floor level of the outside walls, passes the impure air out overhead in the central portions of the barn. It is a good principle to have the air enter so that it will pass over the cows' heads towards the rear rather than from their backs forward. Where the cows face inward, the first of the two systems is excellent; where the cows face outward, the second may be preferable, although either might be used to advantage in either case depending upon conditions.

**5. Miscellaneous considerations,** which may be grouped under the following heads; (a) Provide rooms for office, washing, storage of clothes and weighing (and perhaps the separating) of the milk. The latter should not be done in the barn itself. (b) Running water is desirable, particularly in the milk and washrooms. (c) Power should be available, particularly if a milking machine is used. It is well to allow space for a milking machine and the power to run it in building, even if the apparatus is not to be installed immediately. (d) A silo and storage room for concentrates should be near at hand. (e) Hay storage is most convenient when easily accessible, whether above or at the end or side of the barn. (f) Not more than 2 rows of cow stalls should run lengthwise in the barn; a larger number makes the lighting poor and ventilation difficult. (g) Most good barns are built north and south so as to secure maximum sunshine.

## Arrangement of Cows

Many arguments are advanced in favor of the cows facing each other, that is toward a central alley, some of these being:

(1) Sunlight in the rear of the cows keeps the floor where they walk drier and safer.

(2) The light is brightest at the end of the cow where the milking is done, making the work easier for the milker.

(3) Feeding can be done along one central alley.

(4) The alley can be at the highest level making the drainage toward the rear of the cows—a desirable sanitary condition.

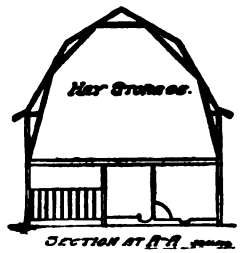



FIG. 573. Section of barn shown below

(5) The centre of the barn can be kept clean and more attractive to the eye of the casual visitor.

(6) The cows do not have to face directly into the light.

(7) It is easier to turn the cows out and handle them generally when the tying and untying are done along the central alley.

(8) Feeding can be done to greater advantage. If the cows face outward, either there is no feeding alley or it is likely to be narrow, because two are required.

On the other hand, some authorities advise

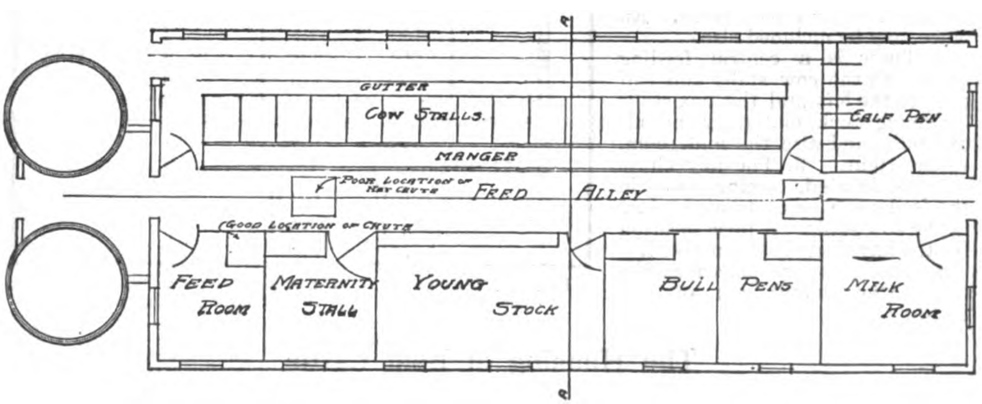



FIG. 574. General dairy barn embodying the features noted on the next page

that the heads be placed outward toward the wall for these reasons:

(1) Manure removal is centralized, all being taken from one alley.

(2) Milking is done more easily, particularly with milking machines, since less shafting is required and also less shifting of the machine from one side of the barn to the other.

(3) Cows come in together through the central alley, staying together until they reach their respective stalls, instead of entering on two sides and perhaps meeting.

(4) Walls are not spattered with manure.

(5) Brings the udders of cows in line where they can be compared and the general appearance of the herd studied. However, the light is not so good for such an examination as if they were along the wall.

Both the schemes are used in practice, and, depending upon local conditions, both are satisfactory and good. It is largely a matter of individual preference, and of adapting the most efficient scheme to the particular location.

### Types of Cow Barn

There are two types of cow barns. One is a general type which takes care of the entire herd and also stores the hay. The other type is developed primarily for milking purposes and consists simply of two rows of cow stalls within a well-lighted, abundantly ventilated structure (Fig. 534). In this case the milk room may or may not be a part of the barn proper. The former scheme is best adapted to the average farm, but for specialized dairies, the latter is worthy of a thorough trial. Fig. 574 shows a dairy barn in which these particular points may be emphasized:

1. It is a general-purpose barn, housing all the animals as well as the milk and feed room. An office may be included also.

2. There is a central feeding alley with the cow stalls and calf pens to the left and the box stalls for young stock, maternity animals and bulls, and also the milk room, to the right. 3. The hay chute is well located, coming down in the feed room so as to avoid dust in the cow stalls. A poor location for the hay chute is also marked.

4. The silos are placed at the north (the shady) end of the building.

5. The calf pen and milk room are placed on the south (the sunny) side.

6. The calf pen is placed directly across from the milk room, making it easier to feed either whole or skimmilk. This has some disadvantages in so far as odors being carried to the milkroom is concerned, but it is excellent from the standpoint of convenience.

7. The hay storage space is conveniently located above.

8. The feed room is handy to the silos so that silage can be mixed with the grain to good advantage.

On the dairy farm, the sires are sometimes housed in a general-purpose barn, but if a number of bulls are to be kept, a special set of bull pens is highly advantageous. Fig. 575 shows the south elevation and floor plan of such a structure suitable for 5 bulls each kept alone. Note that they have a little open run on the south, a part of which is paved so as to give them solid footing just as they step out of their pen. The feed alley is conveniently arranged along the front. Hay and bedding may be stored above. Sliding doors are used to the pens because they are strong and safe. The feed room is on the north side in a central portion, making it handy for feeding as well as for the unloading of feed from the outside.

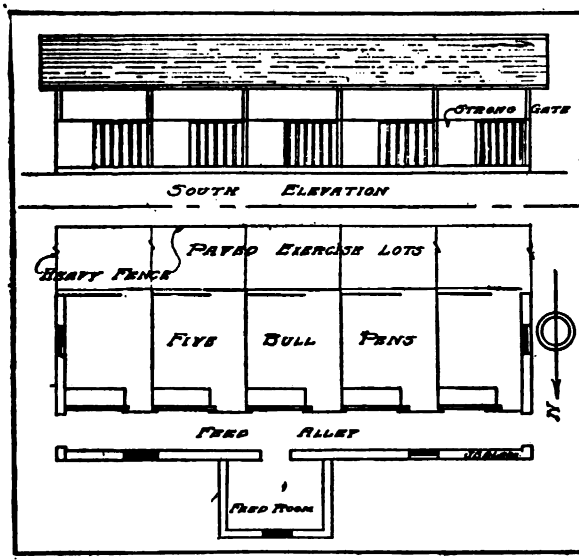



FIG. 575. Elevation and plan of bull pens especially adapted to meet the needs of a pure bred breeding establishment.

## The Housing of Beef Cattle

Beef cattle are housed much more simply than dairy cattle, four general types of barn being used, the first for the breeding herd, the second for the fat-

tening cattle, the third for a combination of the above, and the fourth for temporary shelter in the pasture. Fig. 576 shows a good general-purpose barn for beef cattle. It might be even better if the cows were changed to the west, and the calves, etc., to the east side. The features to be noted in this barn are:

1. A central feed and service alley wide enough to take care of the cattle as well as the feeding operations.
2. Stalls for breeding cows (preferably on the west side) provided with open partitions high enough to keep the cows nicely separated.
3. Abundant windows on both east and west sides, the barn itself running north and south.
4. Calf pens and bull pens (preferably on the east side) where the animals may run out for sunshine. These are connected with outside runs which are not provided for the breeding cows. The latter can be taken in groups through the service alleys.
5. Silos are placed on the north to furnish protection.
6. The feed room is separated from the silos, being placed next to the office for convenience sake. Ordinarily the feed room would be placed next to the silos, but on many beef-cattle farms silage is fed alone. This arrangement could easily be changed.
7. The office is placed on the south where it is nice and warm.
8. Abundant hay storage is provided for above—this is quite essential.

Fattening shed. A feeding barn for fattening beef cattle is shown in Fig. 577. This barn is particularly well adapted for the storage of a large amount of hay. It also gives complete protection to the cattle. Note that the feed bunks for silage and grain feeds are arranged along the outer wall. A feed carrier track could easily be erected between the silos and these bunks. Fattening cattle such as steers which are bought on the open market can be advantageously housed in a very simple open shed facing the south, preferably arranged with hay storage above for convenience sake.

Fattening steers running in groups should be provided with the following conditions: (1) Plenty of open air and sunshine. (2) sh lter from cold winter rains and snows and also hot sunshine. (3) A dry bed to sleep upon and solid footing on arising. Yet it is surprising how well steers will do even if they have to go *knee deep in mud* out to the feed bunks. (4) A place for the hogs following the steers to consume the voided and otherwise wasted grain. It makes considerable difference in the housing of a bunch of steers whether or not an extra hog or two is going to sleep with them. These hogs must be provided for either in a separate structure or in a protected corner of the same building; (5) Handy hay and feed. Hay is best provided and also fed inside, where the cattle can eat and be contented. (6) Open water should always be provided. It is best al-

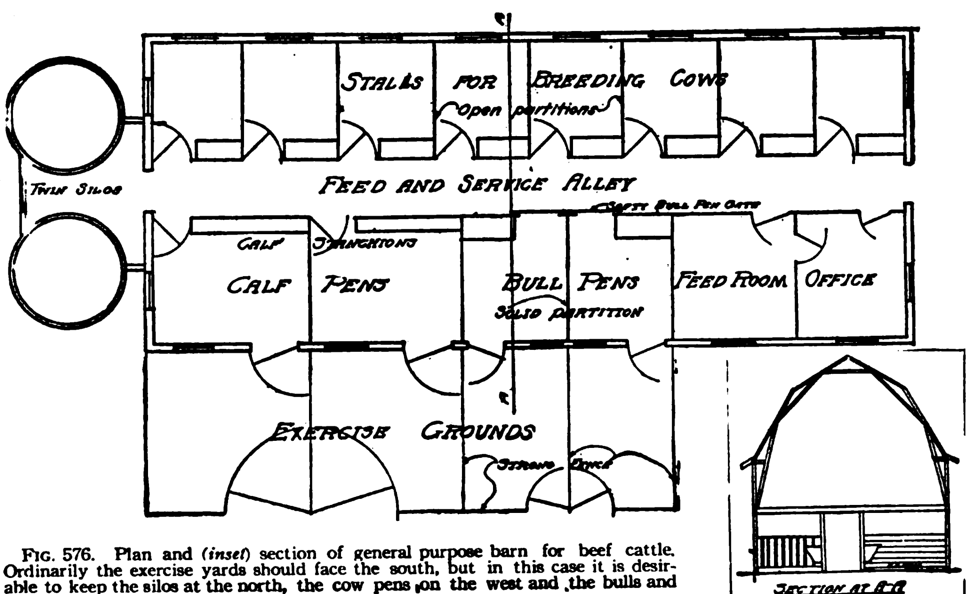



FIG. 576. Plan and (*inset*) section of general purpose barn for beef cattle. Ordinarily the exercise yards should face the south, but in this case it is desirable to keep the silos at the north, the cow pens on the west and the bulls and calves on the east.

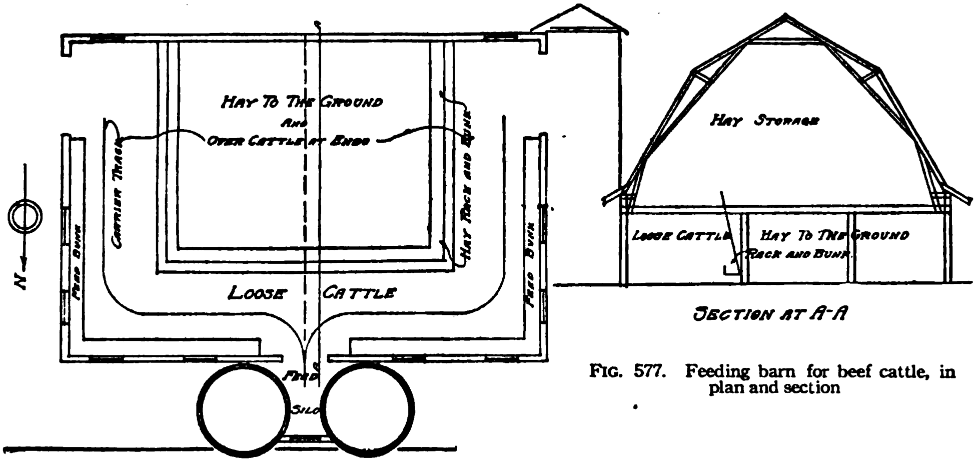



FIG. 577. Feeding barn for beef cattle, in plan and section

lowed inside but a short distance outside is all right, provided the animal has protection from the winds while going to the watering trough. (7) The steer place should be quiet and well away from unusual noises. Steers coming from the range country are not accustomed to the congestion found on the average farm. They often are afraid of men on foot, and shy at other animals simply because they are unusual. A wild steer is made *often* more wild by his environment, whereas for best results his surroundings should be quiet, and in harmony with his nature.

**Points of a good feeding shed.** A shed which provides these essentials is shown above. Note these points in connection with it: It faces the south. Hay and bedding are stored above. The feed rack for hay is handily placed at the north side of the pens. The watering trough is to the south outside of the shed and near by. The paved run extends out a few feet from the shed proper to provide solid footing; here the feed bunks can be placed. Windows are placed in the front or south elevation so as to provide light in the hay mow; if the hay mow is dispensed with they provide for the shed interior. Note further that this shed is wide and open with very little to disturb or interfere with the steers as they lie in it. The straw chutes are placed in a favorable position for throwing the bedding directly to the point where it is needed.

**A handy cattle shelter** built in the woods or in the field or in the pasture is of much importance on many farms. Such a building that is in use on one large farm and which has given excellent satisfaction at a comparatively low first cost embodies the following noteworthy features: (1) It is made of tile blocks, which provide a warm structure. (2) It faces the south. (3) The glass windows provide an abundance of sunlight within. (4) The open entrance door, large and spacious, is placed in the southeast corner. This permits the early morning sun to strike directly into the barn and also insures that southwest winds (which prevail in the Corn Belt) will not blow into it. Storage for hay may be provided on the second floor.

## The Housing of Sheep

In general two types of barns are built for sheep; one a general barn, housing the breeding flock and other sheep in general, and the other is a fattening shed.

Some important features of a general sheep barn are as follows:

(1) Keep things particularly dry under foot because sheep can not stand much mud. (2) Sheep require more floor space in proportion to overhead hay storage than do cattle or horses. (3) Sheep being well provided with a warm covering do not need a very warm, snug barn, but the barn should nevertheless be built with warm walls and so arranged that it can be kept open on the south and east by the handy placement of easily opened large doors and windows. (4) Sheep need protection from rain and snow particularly, and arrangements should be made for getting them under cover whenever storms come. They are particularly prone to stay outside when they should be inside. (5) The walls should be smooth inside so as not to catch and tear the wool. (6) Convertible panels are a

handy asset in the sheep barn, particularly when they are interchangeable and can be used to make pens of different sizes. (7) Ordinary movable feeding bunks and hay racks can be largely used although some permanent racks are in order. (8) A root cellar or silo depending upon which kind of roughage is fed, should be attached. (9) Stove-heating arrangements should be provided for lambing time. Warm lambing pens are also in order. These should be tightly closed off, making provision, of course, for ventilation.

**Points of a good general barn.** A general L-shaped sheep barn with exercise pens to the south and east is shown below. These points should be noted in connection with it:

1. It is built so as to give north and west protection, which is desirable.
2. The silo is placed on the northwest corner handy to the continuous feed alley running around in front of all sheep.
3. The feed room is in the corner handy to the silo and also handy to both ends of the L.
4. A shepherd's room and office is provided next to the feed room on the east where he is close to the ewe and lamb pens.
5. Provision is made in the eastern portion of the L for lambing pens, movable partitions or pens being supplied; these may be also used for rams.
6. The ewe lambs are run in one bunch and the breeding flock in another. If certain members of the breeding flock need special attention they can be taken to the ewe and lamb pens.
7. Exercise pens are provided on the south and west where there is an abundance of sunshine and warmth; this is much better than if the exercise pens were on the north and west where it is cold usually and oftentimes bleak.
8. The exit doors are best if of the sliding sort, but those next to the ewe and lamb pens should be snugly fitted so as to make these pens warm. The ewe lamb, and breeding flock exit doors can be kept open most of the time.

A fattening shed for sheep, whether bought or raised on the farm and prepared for fattening, may be a very simple structure. Hay storage can be provided above the shelter proper although some prefer to have a big feed and passage-way in the front where this is stored. A scale should be placed out of the way, on the north where it can connect with the central feed and passageway. Such a shed is designed simply to furnish protection for the fattening sheep which do best if kept largely in the open, but which need a warm bed underneath a waterproof, snowproof, windproof shelter.

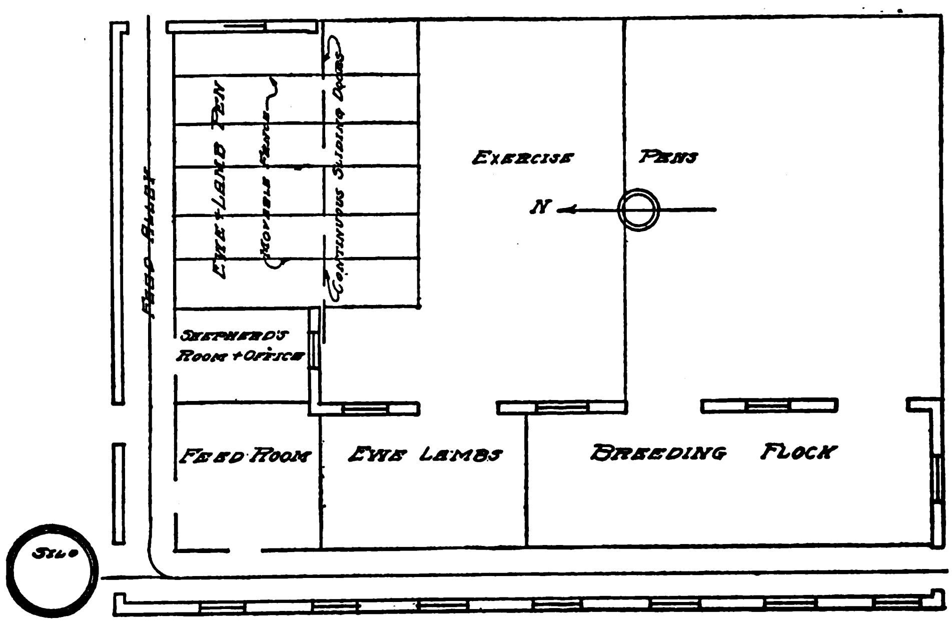



FIG. 578. Sheep barn plan. Sheep need but little protection from cold, except at lambing time, but they must be kept dry and given yard room where they can obtain plenty of exercise

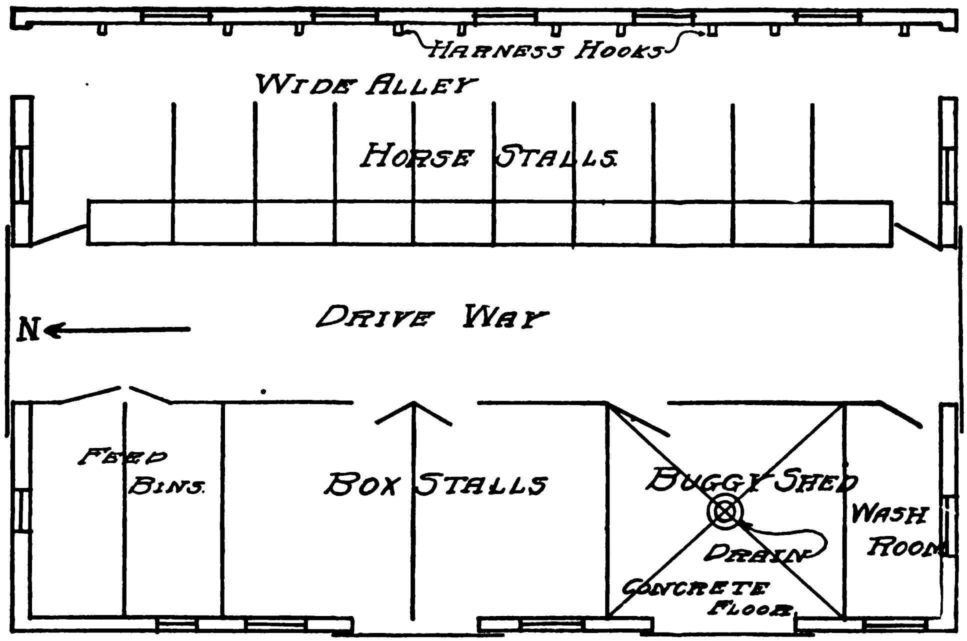



FIG. 579. Plan of a general work horse barn. A harness storage and repair room would be an additional advantage, but for daily use harness is best kept behind the stalls

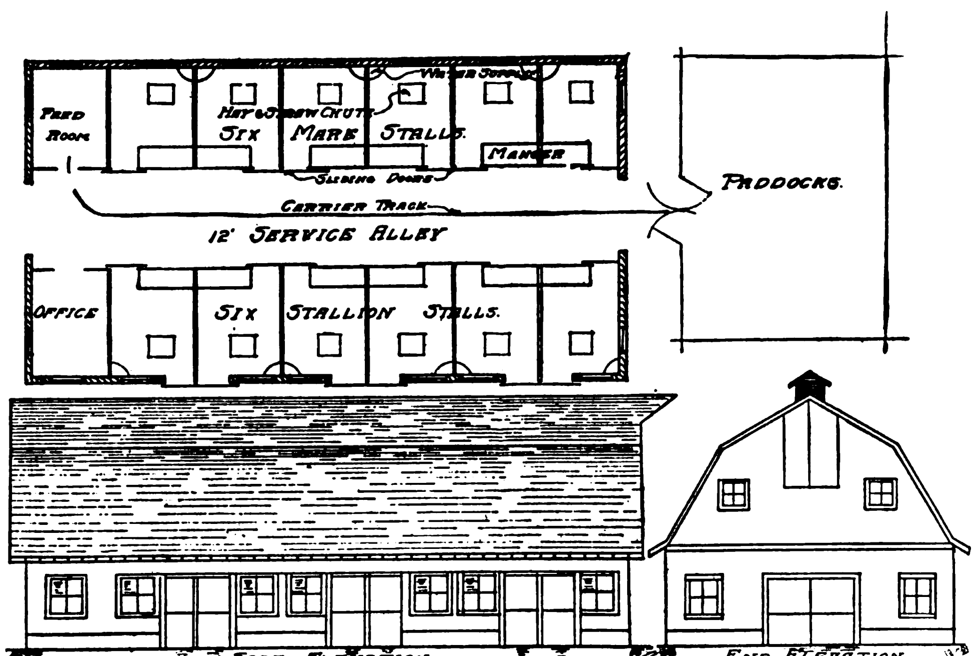



FIG. 580. Plan and two elevations of a stallion and mare' barn. The professional breeder must build attractive structures in which to receive buyers as well as efficient ones in which to care for his stock

## The Housing of Horses

Horses as a class of farm livestock differ from the meat or milk producing animals in that they are kept in large measure for working purposes. This includes of course, their driving and riding, for, though types of recreation for man, from the horse's standpoint these are forms of work. In building a barn for horses, the following points should be given as careful attention as possible:

1. The barn should be handy, and particularly safe and comfortable. Horses being strong, stalwart animals require safe construction or they are likely to injure themselves. A handy driveway and feeding passage, particularly one in the centre with the horses facing it is in order. This is a much safer arrangement than where the horses face out and have to be fed from the "heel end." A place for harness should be provided, preferably to the rear of the horses although handy harness rooms conveniently placed may be used for special harnesses. It is much easier to take the harness from a peg directly behind the horse than to run half way across the barn with it. We must remember that the horse is, or at least may be, a kicking animal, hence the partitions should be tight and solid. Solid, strong floors are also essential. A centre dividing pole where horses stand by pairs in open stalls, are often of advantage. The mangers should be fairly deep yet easy to clean. The floor should be slightly roughened to prevent slipping and safety doors are to be commended.
2. Protect the horse from drafts, particularly after it has come in from work. Ventilation should be natural and easy, rather than draughty and violent.
3. Provide an abundance of light. Sometimes it is well to be able to darken a portion of the stable so as to keep the flies down, but special arrangements can be made for this. The windows should be simply protected by means of iron bars or heavy screen wire to prevent breakage.
4. The floors should be solid but not hard and unyielding. Horses that are compelled to stand on concrete floors often puff up considerably in their feet. Wood creosote blocks are good and heavy wood slatted flooring is excellent.
5. Smooth walls prevent injury and offer no places against which the horses can rub their tails and scrape the hair off.
6. Exercise paddocks should be provided so that they can be turned out easily, preferably on grass. Hard-worked, heavily fed horses should be given their exercise on off days so as not to develop kidney trouble, particularly azoturia.
7. Spacious stalls are highly desirable. Single stalls should be at least 4 feet wide and preferably 5 feet by 8 to 10 feet deep. Double stalls should be at least 8 feet wide, preferably 9 or 10 with the same depth as singles.

**General horse barn.** The ground floor of a general horse barn is shown in Fig. 579. Some features which may be emphasized here are: (1) the central driveway; (2) the horse stalls all on one side; (3) work stalls on the east or early morning sun side; (4) handy entrances to these stalls from the alley way; (5) convenient harness hooks at the rear of the horses; (6) feeding done from the centre; (7) feed bins at the north end of the barn; (8) box stalls on the west side having outside communication to paddocks; (9) buggy shed, washing floor and wash room on the west side to the south; this washing floor can be used for washing horses as well as for wagons. Note also that the buggy storage room opens to the outside. A watering trough may be placed in the wash room if water is available. The central driveway is big enough to drive through; this is quite important particularly in filling the feed bins. The hay chute is best arranged to come down right in the middle of the driveway, preferably close up to the horse stalls on the east.

A good stallion and mare barn is shown in Fig. 580 in which these features should be noted: (1) A spacious service and feed alley. (2) Roomy mare stalls on the west, each provided with a hay and straw chute close to the wall. (3) The mare stalls open to the service alley, whence the mares are taken to paddocks on the north side for exercise. (4) Stallion stalls on the east with separate exits; these may be used for mare stalls. (5) Mangers are placed in the stalls next to the service alley. (6) Sliding doors are arranged so that one door covers one stall openings and is stopped in such a manner that only one of these exits can be kept open at a time; this is advantageous in preventing the possibility of two stallions or two mares getting out at the same time. (7) The abundant lighting through windows placed on the east, west and south sides. (8) The office is placed on the south side as is the feed room; the latter may however, be placed on the north side if deemed advisable. (9) A water supply controlled by a float system is present in each stall, a common float controls all of the concrete troughs, one of which supplies each two stalls.

This is a very handy barn and has been found especially adapted to those farms where a considerable number of mares and stallions are kept.

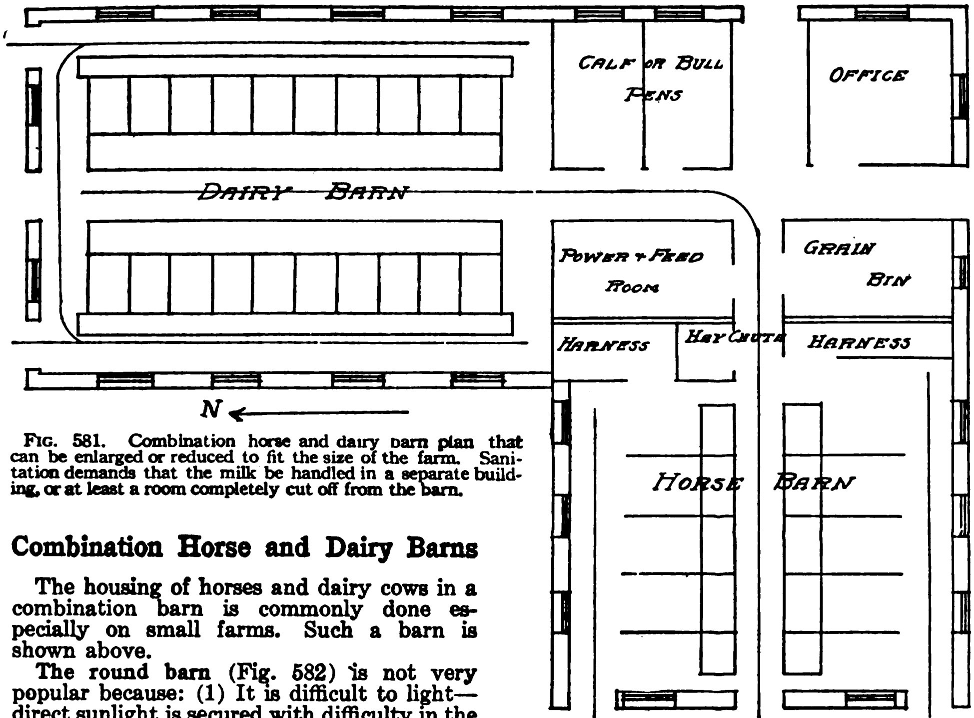



FIG. 581. Combination horse and dairy barn plan that can be enlarged or reduced to fit the size of the farm. Sanitation demands that the milk be handled in a separate building, or at least a room completely cut off from the barn.

## Combination Horse and Dairy Barns

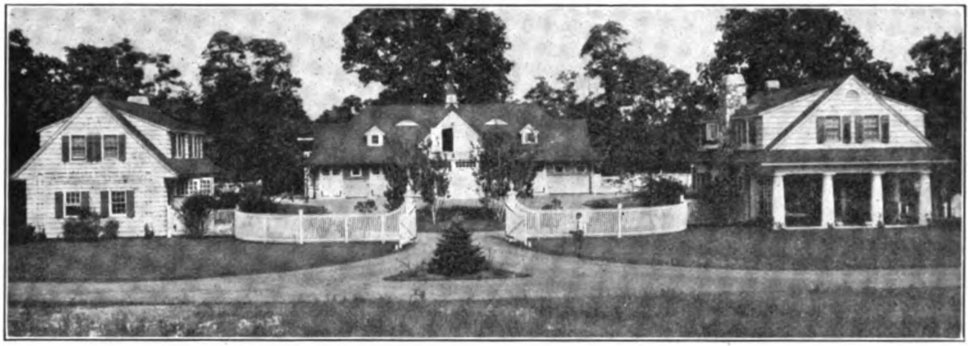
The housing of horses and dairy cows in a combination barn is commonly done especially on small farms. Such a barn is shown above.

**The round barn** (Fig. 582) is not very popular because: (1) It is difficult to light—direct sunlight is secured with difficulty in the interior portions. The north half of the barn is inclined to be somewhat cold at times because it is out of reach of the sunshine. (2) It is hard to arrange satisfactorily. (3) It is not in keeping with the average farmer's scheme of things; he is in the habit of working on a basis of squares and oblongs and a circular arrangement seems odd and uninviting. (4) The stalls are of an odd and somewhat inconvenient shape. (5) It is somewhat difficult to install litter carriers, milking machines and so on because of the circular tracks needed; of course it can be done, but less easily than in a rectangular barn. (6) The centre is usually utilized as a silo; this makes the silage handy, but it has the disadvantage of supplying a double set of walls for the silo which is an expensive procedure. A silo can stand very well by itself without having the protection of an expensive barn wall. (7) It is a difficult shape with which to combine additions and other buildings.

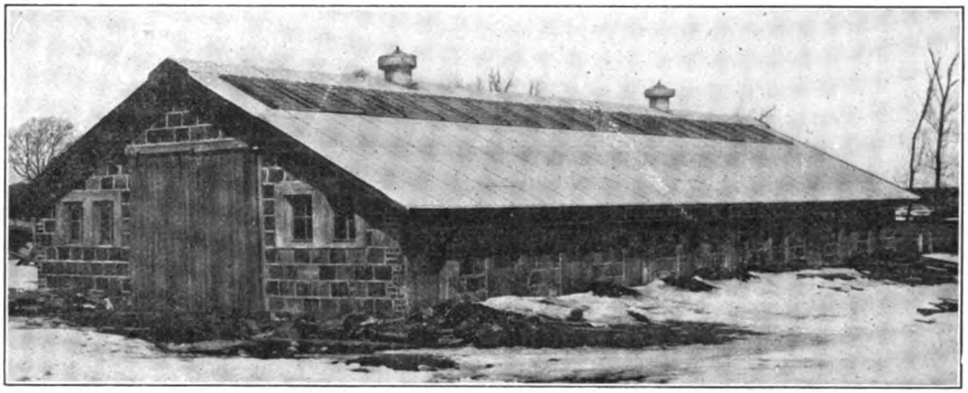
On the other hand a round barn is commendable because it furnishes a maximum of inside area per unit of wallspace; it is also easily built by those who have had experience.

**The bank barn** is less popular than it was in years gone by, before the great advantages of light, sunlight, sanitation, and ventilation were so thoroughly understood and appreciated. Has the disadvantage of being difficult to light, particularly on the side next to the earth bank (usually the north side) and there it is liable to be dark, damp and unhealthy. On the other hand such barns are very warm and comfortable in severe cold weather, and quite cool in the summer time.

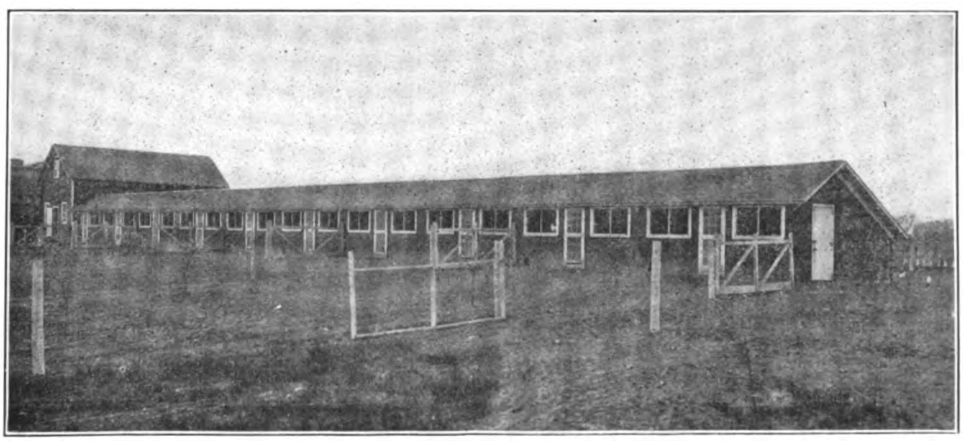
If a bank barn is to be built, Fig. 583 pictorially shows the right and the wrong methods of constructing it. Assuredly a bridge should be provided from the barn across to the other bank, and windows placed in the side of the barn next to the bank; this will permit the sunshine going through the bridge to pass into the barn.



This farmstead is a success because it is efficient as well as attractive

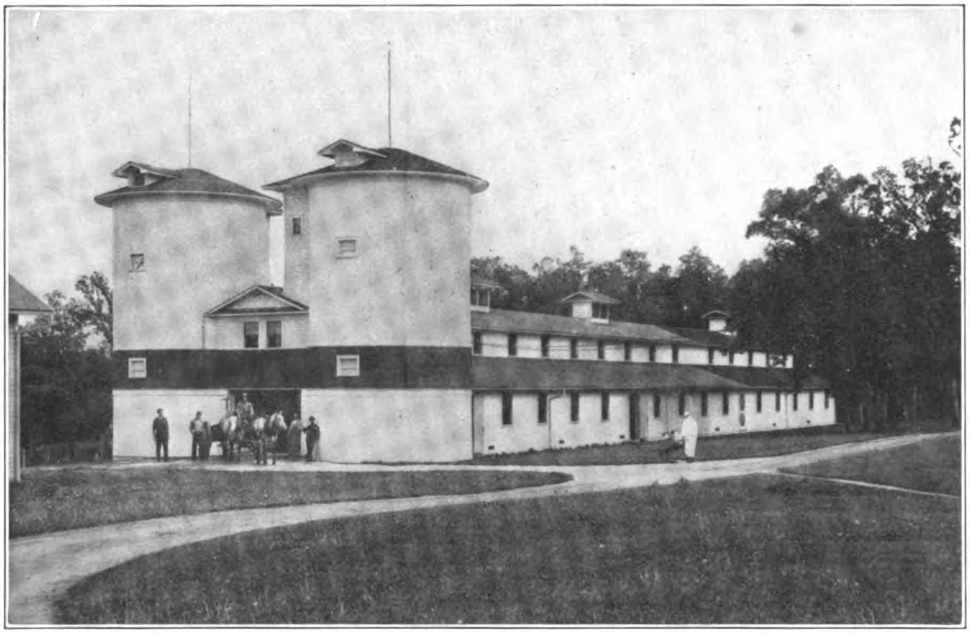


The Iowa sunlight community hog house—a practical building for practical farms

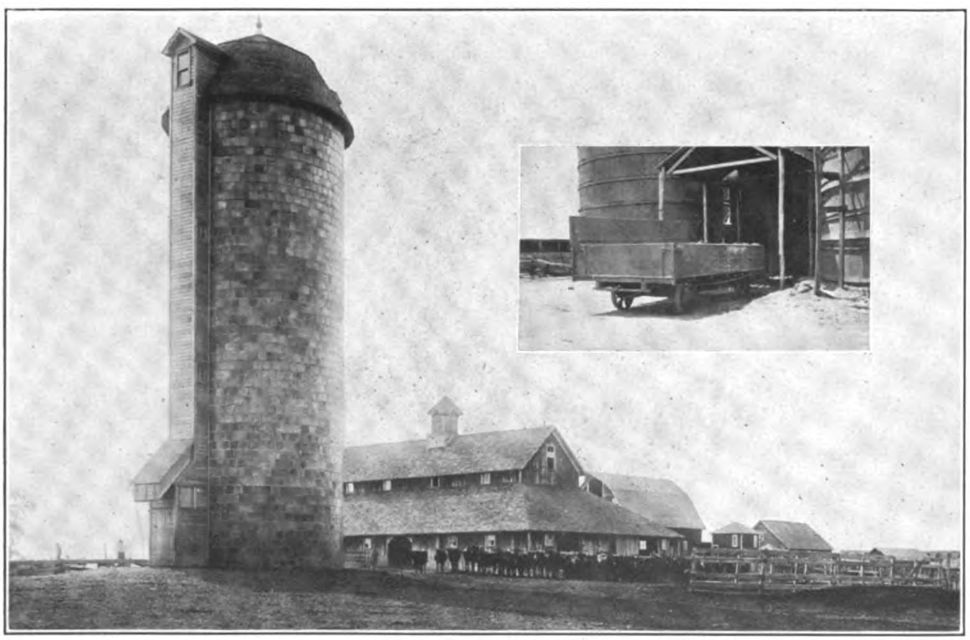


An inexpensive, convenient commercial house for a specialized poultry farm

**IT IS NEITHER THE COSTLINESS NOR THE CHEAPNESS OF A BUILDING THAT MAKES IT A SUCCESS
THE POINT IS: DOES IT GET RESULTS?**



Twin silos and a single-story cow barn on a farm where architectural effect was given careful consideration



A hollow-tile silo and beef cattle feeding barn built first of all for practical results. Inset shows a handy feed wagon for carrying mixed silage and grains

THE SILO, ASIDE FROM BEING AN INVALUABLE ASSET ON THE STOCK FARM, IS OFTEN A STRIKING FEATURE OF THE FARM GROUP. THERE IS A TYPE FOR EVERY PLACE AND EVERY PURSE

Although the types of barns designed to shelter the different classes of farm animals have throughout this chapter been discussed as separate units, there will often be need to combine the essential features of two or more of them in one structure. This may result from the kind of farming followed, from the condition and means of the farmer—whether owner or tenant, from the difficulties of the location with regard to the obtaining of materials, or from the demands of economy. The small farmer will not, of course, require as costly or as extensive buildings as the one who operates a large place and maintains valuable herds and flocks of high grade animals. But on the other hand, the diversity of his limited interests will call for a good deal of careful planning so that all his stock may share one building and still enjoy the conditions that are most beneficial to each of them.

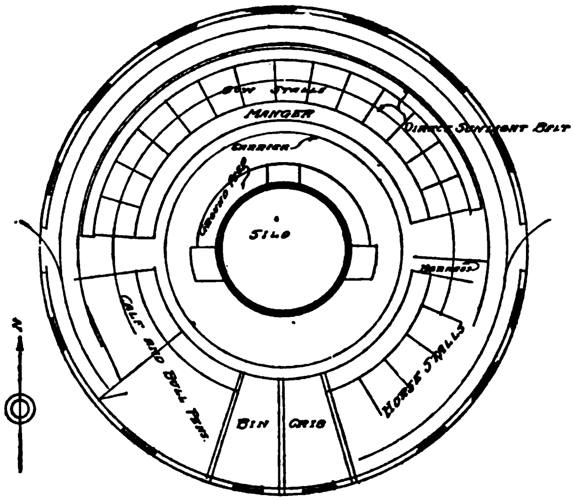


FIG. 582. Plan of a round barn which under certain conditions is an economical and efficient type

There are so many different functions that barns may perform, and so many different kinds of structures that are admirably adapted to such performance that it is difficult to describe any particular types that are entirely suitable for more than a single set of conditions. The aim of the writer has been, therefore, to give general principles and outline certain practices so that the livestock man may have a somewhat definite basis upon which to work in building a barn most acceptable to himself and to his animals under his particular, and sometimes peculiar local conditions.

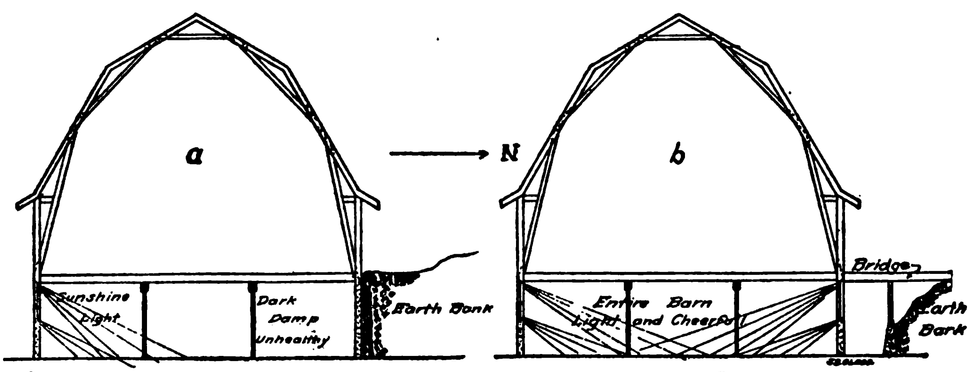


FIG. 583. The bank barn is a common and valuable type in northern sections. The hill into which it is set provides much-needed protection, but light and ventilation must also be provided for. *a* shows the usual method of building such a barn; *b* shows a much better method which should always be followed if possible.

CHAPTER 35

# Farm Poultry Buildings

*By* PROFESSOR H. L. KEMPSTER *of the College of Agriculture of the University of Missouri, who in 1911 organized its Poultry Department, of which he is now in charge. Previously, with the rank of Assistant Professor, he had been in charge of the Poultry Department of the Michigan Agricultural College, from which institution he graduated in 1909. Before entering college he lived and worked on the southern Michigan farm on which he was born. He has prepared a number of experiment station publications, all of which reflect the farmers' view point, without which, as Professor Kempster says, "one couldn't fit in with the atmosphere of the Middle West." The modern cry is for every family to produce as much of its food as possible. A flock of hens is an invaluable help in doing so; but to serve its purpose it must be well cared for and housed. Details of its care are treated in Volume I; what the farmer need know about farm poultry buildings is given here.*—EDITOR.

POULTRY housing plays an important part in successful poultry keeping. If, during inclement weather, the hens are not kept comfortable they will cease to be productive. Young stock will not thrive, unless given the proper protection. Success in handling fowls depends upon 3 important factors: (1) the kind of stock; (2) the poultryman himself; and (3) satisfactory environmental conditions, such as feeding and housing. If the stock is poor, or the poultry keeper is careless or unsympathetic, the results will be unsatisfactory. The poultryman should remember that good housing of poultry is only one of the factors contributing to success, and that, unless it is accompanied by intelligent feeding and personal responsibility, discouragement will result. On the other hand, even though a good ration be fed, there will be times when proper housing is necessary for economical production.

## Essentials of a Poultry House

**Comfort** is one of the essential features of a poultry house. This is equally true in summer and winter. Other points which should be considered are simplicity of construction, economy of building material, efficiency of lighting and ventilation, and the convenience of the attendant. Due regard should also be given to the location and dryness of the house. Money is often spent unnecessarily in providing expensive building equipment. Unduly artificial conditions are neither essential nor desirable in successful poultry raising. A plain, simply constructed house, well-lighted, dry, and properly ventilated without drafts is all that is required. The interior fittings should be simple in design, with as few cracks as possible, thus aiding in the suppression of poultry mites. Lack of light and dryness also encourages disease, which may easily be avoided by the use of poultry houses properly designed.

**Location.** Convenience of location and arrangement is essential to economy of time in the care and management of poultry. Many chicken troubles may be traced to the selection of a site or soil not adapted to efficient sanitation. Perfect dryness is essential. This is quite largely controlled by the type of soil and the

contour of the ground. A light soil, such as a sandy loam, not so sandy, however, but that it will produce an abundance of green food for forage, is most desirable. The lighter, more friable soils can be cultivated more easily than clay and at any time of the year. They also drain quickly, and warm up early in the spring. Heavy clay soils are objectionable, because it is more difficult to keep them sweet and sanitary, as they dry out slowly. The possibilities of cultivation and reseeding are also restricted when extreme dryness and baking occur. The fact that such soils remain muddy longer renders conditions disagreeable for attendants, and a greater number of dirty eggs may result from muddy feet.

A low spot is unsuitable for a poultry house, because surface water is apt to accumulate and damp air always settles in such places. Land which is naturally wet, either because of the nature of the soil or because of springy conditions, should be properly drained. Muddy quarters cause fowls to consume large quantities of filth. Dampness also results in unhealthy flocks. A windbreak should be provided, as it affords protection from the winds and the sun. If possible, the house should be located on a south or an east slope, where the ground will dry and warm up quickly in the spring.

In selecting a location for a poultry house, the farmer usually chooses the one nearest to his home, so that the housewife may conveniently care for the flock. This accounts for the usual location of the poultry house, halfway between the house and the barn, where it is easy for the hens to overrun not only the farm buildings, but the kitchen porch as well. The indiscriminate throwing of feed also encourages the birds to inhabit other buildings than their home. If the farm poultry house is located so as to make it natural for the hens not to overrun the farm buildings, there will be little trouble, provided they get enough to eat at home. Frequently, poultry can be encouraged to run in an adjoining field or orchard by a simple arrangement of the fences.

**Yarding.** As perfect sanitation is one of the requisites to success in poultry raising, the larger the yards the more easy it will be to maintain healthful conditions. While there is no set rule as to the amount of yard space required, if wholesome conditions are to be maintained, 150 square feet of yard space should be allowed each bird. Farmers neglect this important essential. They allow only room for the house, never realizing that the unduly artificial conditions afforded by grassless, hard, filthy yards are not conducive either to health or to economical production. From the standpoint of the farmer, yardage may be desirable at times. In the early spring, the poultry may be confined while the crops are getting a start, after which they may be turned loose. Occasionally the poultry is yarded in order to protect the nearby crops. Then, too, during the brooding period, old stock should not be permitted to run with the young, as the latter will not thrive, if compelled to pick their living with mature fowls. Grain crops may often be grown upon the same ground on which the poultry flock is running, with very little injury to the crop. Corn is especially adapted to such a practice, and it furnishes an abundance of shade, when needed. By plowing the yards occasionally, the soil is exposed to the sunlight, thus tending to destroy disease germs and, especially, intestinal parasites, which latter always frequent yards in which poultry is closely confined. In addition to making the yards more healthful, the growing of crops utilizes the droppings. This sweetens the ground and reduces the feed cost. Permanent sod runs cannot be maintained, if more than 400 hens are kept on an acre. Sod runs, however, do not furnish as much green food as do forage crops. Wheat or rye can be sown in the fall; oats or barley, in the early spring, followed by oats and rape, succeeded by rape and buckwheat. In this way, an abundance of succulent feed can be provided.

FIG. 584. General view of the "Missouri" house, designed to combine the desirable features of all special types in one building in which the farm flock can be housed safely and economically under average conditions and in any section of the country.

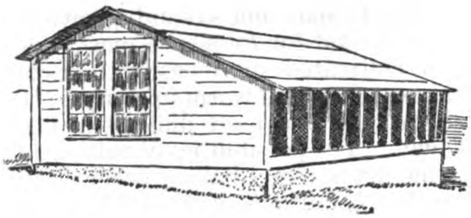


FIG. 585. The "open-front" house provides plenty of ventilation without draughts so long as the other three sides are tight. This may require double wall construction in cold sections where cloth sash may well be used in front in addition to the wire screening.

While the ideal of the farmer should be to fence the poultry out instead of in, and in this way to exclude them from the garden and the dooryard, a little forethought will enable him to follow out some of the above suggestions with little expense without sacrificing convenience.

**Height.** The height of a poultry house should be such that the attendant may work conveniently. This will afford conditions satisfactory for the birds. It is also best to have as little air space in the house as possible. If a roof of sufficient pitch be used, the back, or north, side of the house need not be more than 4 feet 6 inches in height. It is usually desirable not to have the height of the south side less than 6 feet nor more than 8, except in houses of special design. Where light is admitted from the south side only, the front should be a little less than half as high as the house is deep. This affords a satisfactory arrangement of lighting.

**Width.** Generally speaking, narrow houses are more expensive to construct for a given amount of floor space than are wide ones. It is also possible to reduce the amount of floor space allowed each bird with the wider houses. With modern types of ventilation, it has become more important to arrange the roosts at a considerable distance from the front. No house should be less than 12 feet deep, unless constructed for special purposes. The nearer square a house is, the cheaper it is to construct. A house 16 feet deep probably satisfies the requirements as well as any, although many stations are recommending houses as large as 20 to 25 feet square.

**Size.** The size of the house will depend upon the number of hens that are to be kept. The common rule in poultryhouse construction is to allow 4 square feet to a bird. A house 20 feet square is sufficient for 100 hens. Each hen will have plenty of room. In fact, under mild climatic conditions, 125 could be housed temporarily with no ill effects. On the other hand, it would not be advisable to crowd the house where weather conditions demand close confinement over a long period. A house containing only 150 square feet of floor space, while rated to house 35 birds, will be crowded if more than 25 birds are housed in it. It is thus seen that the larger house is the more useful.

**Light.** Properly lighted houses are necessary for satisfactory production. Sunlight is the cheapest disinfectant possible. Dark quarters are conducive to filth, dampness, and disease. A dark house is also unpleasant, and, in addition, shortens the period that a hen can feed. This may mean all the difference between poor and good egg production. Experimentally, it has been shown that, by artificially lengthening the day during the winter, the egg production more nearly approaches that which is expected in the spring. Where the open-front, or muslin, type of ventilation is used, a safe rule is to allow 1 square foot of glass to every 12 or 15 square feet of floor space.

Too much window space is not advisable. A house with such an excess is subject to extremes in temperature, due to warming up on sunshiny days and to the radiating of a corresponding amount of heat at night. In winter, the high temperature causes the combs of the chickens to become tender and more liable to freeze than in houses of more uniform temperature.

A common mistake is to place the windows too low. Direct sunlight is more effective in the middle of the pen than near the front. In general, the height of the tops of the windows should be a little less than one half the width of the house, that is, in a house 16 feet deep, the tops of the windows should be 7 feet high. The windows should be so distributed that there will be no dark corners. In fact, there are no objections to placing windows on the east, west, and north sides. With such an arrangement, there are no dark corners; and in this way the laying of eggs on the floor is discouraged. Also, when light comes from one direction, the hen always faces in that direction when she scratches, and, in consequence, there is a gradual movement of the litter toward the back side. With light evenly distributed, hens face in all directions. There is no piling up of the litter in dark corners, because there are none. It is interesting to note that to an increasing extent windows are being installed on all sides of poultry houses. Windows may be covered with wire screens, so as to keep the poultry in and the sparrows out.

**Ventilation.** An efficient system of ventilation is the most essential feature of a poultry house. Birds cannot be comfortable if drafts are present in the house; and yet there is no class of livestock that demands so much fresh air as do chickens. This is because the liquid excreta of fowls is passed off almost entirely through their lungs, for they have no sweat glands and their feces are comparatively dry. Unless a poultry house is well ventilated, it is sure to be damp; and in a damp house there are sure to be frozen combs in winter. A damp, cold atmosphere is

much more harmful than a dry, continued cold of lower temperature. Other indications of poor ventilation are frost on the windows, walls, and roof, and a "chicken smell" or closeness in the house, due to the foul odors and tough, leathery litter. Such conditions will result in an abundance of colds, a lack of thrift, weakened vitality, and poor egg production. When they occur, better ventilation should be secured.

Probably the most popular type of ventilation is that employing cloth curtains or frames. A cotton frame allows the air to work through the cloth and yet keeps the chickens out of a draft. The cloth also admits an abundance of light. The cotton-front house is efficient as long as the cloth remains dry. If it becomes wet, it retards the movement of air. Even when cloth frames are used, the frames should be raised a greater portion of the day, so as to air out the house. The frames may be hinged at the top or side, or made to slide up and down like any window. A moderate-sized frame is more easily handled and permits more accurate control than a larger one. Where cloth is used in houses 16 feet in depth, the amount of cloth is the same as of glass, that is, 1 square foot of cloth to every 12 to 15 square feet of floor space. If the house is 10 feet deep, use 1 square foot of cloth to every 20 square feet of floor space; and, if the house is 20 feet deep, use 1 square foot of glass to every 10 square feet of floor space. The cloth curtains should be located on the south side of the house, farthest from the roosts.

**Open-front ventilation.** Another type of ventilation is that known as the open-front. This type consists of an open space on the south side, covered with wire screen only. The popular size of house for the open-front is 20 feet square. It is not adapted for houses of less depth. On the south side of such a house is an opening 3 feet wide one foot from the floor, running the entire length. In the original open-front types, the south side was only high enough to permit the opening. The roof was of unequal spans, the front span being twice as long as the back one, the ridge of the roof running east and west. The windows were put in the west end, and a door in the east. During winter, the success of ventilation of this type depends upon having the sides, back, and roof of the house entirely air-tight, so that there may be no drafts. The wind will drive in a short distance, but never to the roosts, which are on the north side and located above the top of the open space. There is a gradual outward movement of the air within, thus insuring an abundance of ventilation. The open-front type has an advantage over all other types, in that it requires no adjusting, never plugs up, and always works. This type adapts itself to temperature changes without constant attention, and in this way reduces to a minimum

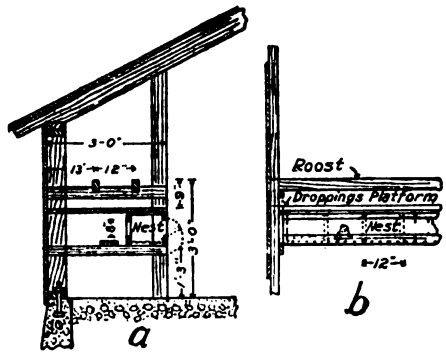



FIG. 586. Desirable arrangement of roosts, droppings board and nests, with dimensions, shown in section as seen from the end (*a*) and front (*b*).

the labor of caring for the house. It probably meets the requirements of a simple, effective farm poultry house more nearly than any other type that has been previously designed.

An item often overlooked in the construction of poultry houses is the summer ventilation. This is particularly the case in the South. It should not be overlooked in any country where the temperature gets uncomfortably warm. There should be openings on the north side, in order to insure a free circulation of air during warm weather. One of the advantages of having windows on more than one side is that by removing the windows the openings are made.

**Tight walls necessary.** The walls of a poultry house should be tight. This is necessary, so as to avoid cross drafts. Nothing seems to affect the health of the birds more quickly than does a cold wind. Colds are sure to develop, and these may pave the way for more serious infections. While wood is more frequently used, hollow tile or hollow concrete blocks may be employed, although they are much more expensive. Unless there is a hollow space in the cement construction, the walls are apt to sweat and the house become damp. The same is true of stone construction.

When wood is employed, it makes little difference what form of the material is used, so long as the wall is such that the air cannot sift through in winter. Matched flooring, sided up and down, makes a tight joint; and, in many sections, car siding can be obtained at more reasonable prices. With matched material, a tighter joint may be obtained by painting the joints when the wall is being laid. There will also be fewer cracks if well-seasoned lumber is used.

It is equally necessary that the roof be tight also. Sheeting the house with an extra ceiling on the inside is unnecessary. For roofing, probably the most common material is some brand of roofing felt, which is easily laid and which forms a tight roof. It

should be laid on a smooth surface. If shingles are used, a cheap grade of roofing paper should be put down first, otherwise the wind will sift through the shingles. This necessitates laying a fairly tight roof before laying the shingles. If a metal roof is used, the roof should be prepared as for shingles, that is, the roof boards should be covered with a cheap grade of roofing paper. If this is not done, the house will be extremely hot in summer, and in winter there will be moisture condensation on the roof, resulting in a damp house.

**Interior arrangement.** Economy of floor space, simplicity of construction, the fewest new-fangled ideas possible, and convenience in handling the fowls, are all points to be observed in the arrangement of the interior of a poultry house. All fixtures should be portable and easily removable, so as to make thorough cleaning possible and easy; also, they should be up off the floor, so that the entire floor space may be used by the hens for scratching purposes. There should be as few cracks and crevices as possible, for in these filth accumulates and parasites thrive. Feed boxes, or hoppers, should have sloping tops, so that birds cannot roost upon them. In fact, there should be no place in the house for the hen to perch except the roost.

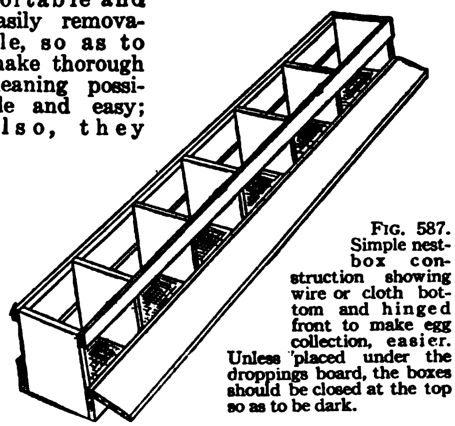


FIG. 587. Simple nest-box construction showing wire or cloth bottom and hinged front to make egg collection easier. Unless placed under the droppings board, the boxes should be closed at the top so as to be dark.

**Floors.** One of the main things that contribute to the securing of a dry house is a satisfactory floor. Of the 3 types of floors—earth, board, and concrete—the earth floor is perhaps the most common, and certainly the cheapest to construct. The most satisfactory floor, however, is of concrete. It should be kept covered with litter to prevent the fowls from developing sore feet, but other than this, its only objection is the original expense. Earth floors have the following disadvantages: the presence of dust in the house, which is irritating and disagreeable to the chickens as well as to the caretaker; the possibility of rat invasions; the necessity of removing a portion of the foul earth each year and replacing it with fresh; and the more frequent cleaning necessary, because an earth floor soils the litter and becomes sour and filthy quicker. Obviously, the earth floor involves more labor and expense in care and upkeep than does a concrete floor.

In constructing a floor of either type, care should be taken to have the floor level at least 6 inches higher than the surrounding ground, so that the floor will not become wet from surface water outside. Some provision should also be made to prevent the rise of water to the surface of the floor by capillary attraction, which takes place like the rise of oil in a wick. Some coarse material, such as cinders or coarse stone (cinders preferred), will serve the purpose. Tamp well a 4-inch layer of cinders and on top of this put 3 inches of concrete and a finishing coat or, to make a really satisfactory earth floor, on top of the cinders put a 2-inch layer of damp clay. Pack hard, smooth well, and let dry. After it has dried, it should be covered with an inch of loose earth, which tends to discourage hens from digging holes in it. If the foregoing suggestions are carried out, there is no reason why the floor of the poultry house should not be dry.

**Roosts.** Roosts should be located in the warmest part of the house. With the open-front and cloth-front types of ventilation, they should be located on the north side. If placed on a level, there will be no tendency for the hens to crowd to the top roost, as is the case when they are placed ladder fashion. Roosts should be smooth, free from cracks, firmly placed, and not less than 2 inches in diameter. Poles or 2 x 4s placed on edge, with the upper corners planed off make sensible and satisfactory perches. They should be placed not less than 15 inches from the wall, at least 20 inches from the roof, and about a foot apart. From 8 to 10 inches of roosting space should be allowed for each bird.

**Droppings platform.** When droppings accumulate on the floor, the house becomes unclean. The birds are continually running over the droppings and, in this way, the feed is contaminated. There is also less space for the hens to use for scratching purposes. A platform to receive the droppings increases the size of the house and renders conditions more healthful for the fowls. This platform should be 6 inches below the roosts, so that the droppings may be removed without removing the roosts. If the platform is built of smooth material, the droppings can be easily removed.

**Nests.** Darkened nests are desirable, for they furnish seclusion to the hen and lessen the amount of egg eating. A too dark nest, however, encourages broodiness. It is also important that the nests be well ventilated during the summer. Portable nests facilitate cleaning. A common method of installing nests is to place them under the droppings

platform at the front edge. Such an arrangement may place the nests so low that the floor space underneath will be little used for scratching purposes. This should be avoided. Where light comes from the south side only, the space at the back of the nests may be dark, and the hens will thus be encouraged to lay on the floor. Nests under the droppings platform are the easiest to construct. Twelve-inch boards are cut into 14-inch lengths and set on edge 13 inches apart; 1 x 4-inch strips are nailed along the lower edges, and 1 x 2-inch strips along the upper edges. Between these strips on the front, an 8-inch door is placed. The bottom of the nest should be covered with hardware cloth, 5 meshes to the inch. This allows all dirt and dust to drop to the floor, and makes frequent cleaning unnecessary. The nests rest on cleats at each end. Along the back is nailed a board upon which the hen may jump when entering. One nest should be provided for every 5 or 6 birds.

**Partitions.** Where all the poultry is quartered in one house, a partition is necessary to separate the pullets from the old hens. Later on, a separate pen is convenient to use for special breeding pens and in many cases is used for sitting hens during the spring. In order to prevent drafts, long houses need solid partitions either of wood or screen covered with cloth. These should be placed every 50 feet. In some houses, the solid partition extends only to the edge of the droppings platform. All partitions should be solid at least 2 feet high, to prevent the male birds from fighting through the partition.

**Water stands.** It is advisable to put watering utensils upon a stand at least 18 inches high. They can be built attached to the wall, or as separate stands. This prevents straw and refuse from the floor from collecting in the water, making it more sanitary. Solid tops collect more filth than do those made of slats or of wire.

**Roosting closets.** At one time, it was recommended that a curtain frame be arranged so as to drop down and inclose the birds in a small space at night. This has since been found unnecessary and the practice has fallen into disuse.

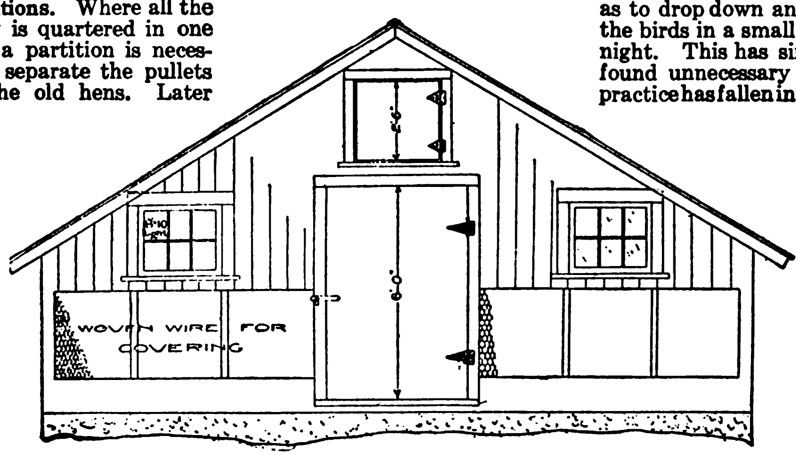


FIG. 588. Diagrammatic front view of the Missouri house showing glass windows, openings to be covered with netting and when desired, equipped with cloth screens, and the window through which straw is packed into the upper story.

## Types of Poultry Houses

**The "Missouri" house.** The "Missouri" house, so called by the designer, the writer, attempts to combine the desirable features of all poultry houses in a house adaptable for the average farm flock. While designed for Missouri conditions, it has been successfully used in New Hampshire, as indicated in the second annual report of the New Hampshire Poultry Growers' Association, which says: "During the winter the birds not only kept in the best condition, but gave good egg production." This shows that the house is suitable for cold climates, and experience at the University of Missouri justifies its being recommended even for warmer climates.

Since the average farm flock numbers from 100 to 150 birds, this house is 20 feet square. The ridge of the roof runs north and south, the roof being of the gable type, that is, of equal spans. In such a house, there is an advantage in having the end face the south, for it permits the windows on the south to be placed

higher than would be possible in the side walls. The walls are 5 feet high, the roof being 11 feet high at the peak. The south end contains a door in the centre and windows each 2 by 3 feet on each side. These windows are placed above a 30-inch-wide opening which is 1 foot above the floor. This opening extends the entire length of the south side on each side of the door. It is covered with wire netting, which keeps the hens in and the sparrows out. In stormy weather, this can be closed by means of a cloth curtain, if deemed advisable.

**Light.** On the east and west sides are 2 windows each 2 by 3 feet. There is another in the back. Those on the sides are placed as high as possible, but the one on the north is situated next to the floor underneath the droppings platform. The advantage of even lighting has already been mentioned.

**Ventilation** is by the open-front method, supplemented by the straw loft which has been a common feature in poultry houses for years. To form the loft, the joists or collar beams which tie the roof together are placed just high enough to afford sufficient head room. These can be covered with 1 x 4s placed about an inch apart, or poles may be used. The loft is filled with two or more feet of straw which is an absorbent, removing damp air from the house. It also protects the fowls during the hot weather by acting as insulation. Such a house is at least 4 degrees cooler during the hottest part of the day than other types of houses. Of the straw loft, Professor Herner says: "It is quite dry in the coldest weather and is easily ventilated." As compared with the "shed-roof" type, he says: "The shed-roof house is always damper and colder in winter and, while the gable roof will cost more, the difference in efficiency is well worth the additional cost."

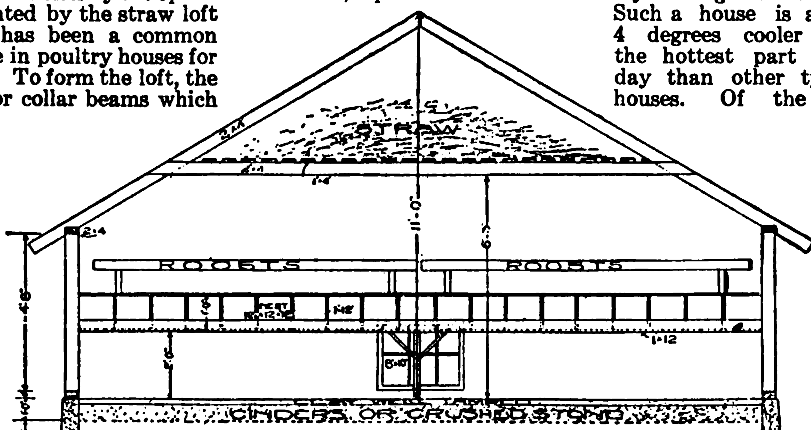



FIG. 589. Cross section through the Missouri house. This suggests a number of excellent and economical construction features, but the farmer who makes best use of them is he who adapts and develops them to meet his particular needs

**Materials.** The walls are constructed of car siding, which is similar to flooring, except that it is beaded. The roof is made of ship-lap covered with shingles. It is necessary to have a tight roof. The roosts are placed on the north side, as suggested on a previous page.

BILL OF MATERIAL FOR MISSOURI POULTRY HOUSE

| USE | PIECES | SIZE | GRADE | BOARD FEET | COST | TOTAL |
|---|---|---|---|---|---|---|
| Framing | 19 | 2 x 4 – 16 | 1 | 203 | $2.50 | $ 5.08 |
| Rafters | 22 | 2 x 4 – 12 | 1 | 176 | 2.50 | 4.40 |
| Plates and sills | 8 | 2 x 4 – 20 | 1 | 107 | 2.50 | 2.68 |
| Studding and framing | 1 | 2 x 4 – 10 | 1 | 7 | 2.50 | .18 |
| Roosts | 5 | 2 x 4 – 20 | 1 | 74 | 2.50 | 1.85 |
| Finishing | 6 | 1 x 4 – 10 | 2 | 20 | 2.00 | .40 |
| Finishing | 1 | 1 x 4 – 16 | 2 | 6 | 2.00 | .12 |
| Finishing | 4 | 1 x 4 – 10 | 2 | 14 | 2.00 | .28 |
| Finishing | 8 | 1 x 4 – 12 | 2 | 32 | 2.00 | .64 |
| Floor for loft | 52 | 1 x 4 – 14 | 2 | 260 | 2.00 | 5.20 |
| Sides, car siding | ........ | 1 x 6 – 10 | ....... | 600 | 2.00 | 12.00 |
| Roof and droppings platform ship-lap | ........ | 1 x 8 – 12 | ....... | 720 | 2.25 | 16.20 |
| Shingles | ........ | ............ | ....... | 5½M | 3.00 | 16.50 |
| Sashes. | 7 | 6-light 8 – 10 | ....... | ....... | .60 | 4.20 |
| Front and over windows, wire netting. | ........ | 3 – 32 | ....... | ....... | .04 | 1.28 |
| Hinges | 1 pair | ............ | ....... | ....... | .10 | .10 |
| Materials, excluding nails and foundation | | | | | | $ 71.11 |
| Labor | | | | | | 28.28 |
| Foundation, 3 cubic yards at $6 | | | | | | 18.00 |
| TOTAL | | | | | | $117.39 |

**The cloth-front type.** The cloth-front poultry house (Fig. 590) is representative of that type of ventilation. This particular house is 14 by 24 feet. It will house comfortably 70 hens. For a flock of 100 hens, it would be built 14 by 28 or 16 by 24. This house is constructed upon a concrete foundation 6 inches wide, 8 inches above ground, and extending under ground to below the frost line. A concrete wall is advisable for any permanent structure. It adds durability to the house, and eliminates the trouble from sagging and warping which may accompany houses with poor foundations. The south side is 6 feet and 8 inches. The studs are put 2 feet apart. The roof known as the "combination type" is best adapted to wide houses, the front span being one half the length of the back span. If the side walls were 6 inches higher, a shed or "shanty" type of roof could just as well be used.

FIG. 590. A simple but well-constructed colony house of the cloth-front type. This will house a large enough flock to supply the farm needs and a generous surplus besides.

The front consists of four windows, each having for its upper sash a cloth frame which slides up and down while the lower sash is a 6-light 10 x 12-inch glass window. This allows 1 square foot of glass and cloth to every 16.5 square feet of floor space. The cloth frames are of a size convenient for the control of ventilation, it being possible to open as many as necessary to supply a sufficient amount of fresh air, varying the number of open frames with the nature of the weather. When open, there are no drafts on the birds, because they are on the floor. In extreme cold or stormy weather, the frames are closed at night. This arrangement of cloth frames has one serious objection which is that when the curtains are dropped down they cover the glass. This interferes with the direct sunlight. Hinging at the side or end and opening in will remedy this.

The roosts located at the back side are made of 2 x 4-inch material placed on edge, the upper corners being rounded off. They are set in notched boards at the ends, and run the entire length of the north side. Droppings platform and nests are placed beneath. The rest of the equipment is a feed box 4 feet by 16 inches with sloping top and a water stand. The feed box has two compartments, one for ground feed and the other for whole grain.

BILL OF MATERIAL FOR A HOUSE OF THE SHED-ROOF TYPE 14 BY 28, 8 FEET HIGH IN FRONT AND 6 FEET HIGH AT BACK

| USE | PIECES | SIZE | BOARD FEET | COST | TOTAL |
|---|---|---|---|---|---|
| Rafters | 15 | 2 x 4 – 12 | 160 | | |
| Plates and sills | 10 | 2 x 4 – 14 | 93⅓ | | |
| Studding, Front | 7 | 2 x 4 – 16 | 74⅔ | | |
| Studding, Back | 7 | 2 x 4 – 12 | 56 | | |
| Studding, Ends | 2 | 2 x 4 – 14 | 18⅔ | | |
| Centre supports | 2 | 2 x 6 – 14 | 28 | | |
| Centre posts | 1 | 2 x 4 – 16 | 10⅔ | | |
| | | | 441⅓ | $2.50 | $11.02 |
| Siding | .. | ......... | 600 | 2.50 | 15.00 |
| Sheeting for roof | .. | ......... | 506 | 2.50 | 12.65 |
| Door framing | 1 | 1 x 6 – 16 | 8 | | |
| Door casing | 1 | 1 x 4 – 16 | 5⅓ | | |
| Door sill | 1 | 1 x 8 – 4 | 5⅓ | | |
| Window frames | 4 | 1 x 6 – 16 | 32 | | |
| Window casing | 4 | 1 x 4 – 16 | 21 | | |
| Window sills | 1 | 2 x 8 – 12 | 16 | | |
| Finishing | 4 | 1 x 4 – 16 | 22 | | |
| Corner boards | 4 | 1 x 4 – 14 | 18⅔ | | |
| Roost-pole supports | 3 | 2 x 4 – 14 | 26 | | |
| Roosts | 6 | 2 x 4 – 14 | 56 | | |
| Droppings platform | .. | ......... | 112 | | |
| Nests | .. | ......... | 60 | | |
| Rough total | | | 400 | 2.50 | 10.00 |
| Sashes | 4 | 6-light 10 x 12 | ........ | ....... | 3.00 |
| Roofing paper | .. | ......... | 6½ squares | 1.75 | 11.38 |
| Hardware | .. | ......... | ........ | ....... | 4.00 |
| | | | | | $67.05 |

**Cost of poultry houses.** The cost of a poultry house will vary with the material used and the economic conditions of the country and particularly of the community. According to figures given on a previous page, the cost of materials was about 70 cents a bird. Lewis, in "Productive Poultry Husbandry," gives bills of material for several types of houses and states that the material cost is from 88 cents to $1.12 a bird. The accompanying bill of material is for a house of the shed-roof type to hold 100 hens.

## Buildings for Special Purposes

**Incubator cellar.** An incubator cellar should not be subject to temperature changes and yet should have provision for adequate ventilation. The humidity should be relatively high and no direct sunlight should strike the incubators. Under farm conditions, the basement of the house or a cave cellar is frequently used. A basement window covered with cloth or a cupola ventilator in the cave cellar will furnish adequate ventilation for 1 or 2 machines.

An incubator cellar should be placed 4 or 5 feet in the ground. The ceiling should be comparatively high, and the walls, if not double, should be constructed in such a way that the room is not influenced by outside temperature. Concrete or hollow tile is suitable in this connection. The superstructure may be used for any purpose, such as a feed house, laying house, etc. The extra space will add to the efficiency in utilizing the building.

The windows in an incubator cellar will necessarily be placed high and should be double, the outer sash being hinged at the top and the inner sash at the bottom. If neither sash is opened more than 45 degrees, the air will circulate through the cellar, but will not strike the incubators.

**Brooder houses.** In planning a brooder house, the type of heating determines the kind of house to build. There are 3 popular methods of heating brooders: (1) lamp brooders, which use kerosene oil; (2) coal-burning brooders; and (3) hot-water brooding systems.

**Lamp brooders.** For lamp brooders, a small portable colony house is generally used. A house of this kind may be used in the spring for brooding, as a colony house for housing chickens on the range in summer, and as a special pen for breeding hens in winter. A good size of house for this purpose would be about 7½ feet by 10 feet. It is best not to have it too large, as it will be clumsy and difficult to move. It should be placed on runners for that purpose. There will be sufficient headroom if it is made 4½ feet high at back and 6½ feet in front. A door, 2½ feet wide, should be placed on the south side. There should also be 2 windows, preferably one on each side of the door. These should be placed 18 inches above the floor. Two 6-light 8 x 10-inch glass windows will furnish sufficient light. The window frames should be made a foot longer than necessary, and this space covered with a cloth frame for ventilation purposes. A board floor is essential in a portable house, as it keeps the chicks dry and makes the house ratproof. By means of the portable house the chicks can be raised near the house, and close attention given them. Later, they can be moved to the range, such as an orchard, cornfield, etc., where an abundance of shade, green food, and insects will furnish conditions ideal for economical and rapid growth.

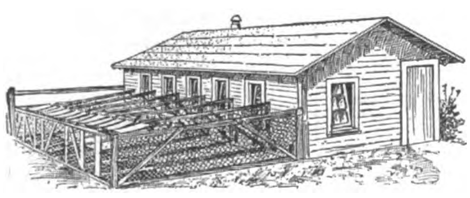


FIG. 591. A good type of brooder house for the farm. The runs are partly covered so that some shade may be provided. The soil in them should be kept healthy by frequent spading and planting to a quick-growing crop.

**Coal-burning brooders.** The brooder-stove method of brooding involves the use of a larger house than the portable house described above, although the latter house may be used. Any room 12 feet square is of sufficient size for a brooder stove. The room should be so arranged that the chicks may have outside runs. In fact, it is practically impossible to raise chicks, unless they have access to the earth. A plan often employed is to partition off a part of the laying house and use this for brooding. The objection which might be raised to such a plan is that the ground

surrounding a permanent poultry house is sure to become contaminated, and conditions will not be favorable for satisfactory growth. There is no reason why a yard for chick raising should not be attached to the permanent house; and, if due precautions are taken to keep the mature stock off, it will serve for brooding purposes for a long time. Yard cultivation will lessen the danger of trouble from intestinal parasites. With the coal-burning brooder stove, a series of pens may be attached to each other, in which case the construction would be the same as for a house for laying purposes.

**Hot-water brooders.** The third type of brooder arrangement is that employing hot water. Such a house will vary in length and width, depending upon its capacity and whether hovers and pens form a single or a double row. The method of heating is by means of a series of hot-water pipes running underneath the floor of the pens. These pipes are boxed in, so that the chamber is completely isolated. There is a partition in the box corresponding to the partition in the pen. This makes each pen a unit by itself. From this heated chamber the heat is conveyed to the hover above by means of pipes about 6 inches in diameter. The hover is covered with a circular disc, 2 feet in diameter, covered with felt folds, which retain the heat. There is thus a continual flow of fresh air into the hover. With any type of brooding, it is objected that a warmed floor causes weakness of legs and loss of vitality. In modern hot-water types, the heated compartment is separated from the hover floor by an air space, thus avoiding the heated floor. The warm air enters the hover at the top, so that, following nature, the heat comes from above.

A hot-water brooding house must contain an alley for convenience, a row of hovers next to the alley and, corresponding to the hovers, a series of pens. This alley should be 3 or 4 feet wide, the hover chamber 3 feet wide, and the pen as long as may be deemed necessary, usually about 6 feet. A single row of hovers would necessitate a house about 14 feet wide; a double row, a house at least 22 feet in width. The house with a single row of hovers would run east and west, thus permitting runs on the south. A house with 2 rows of hovers would run north and south, having runs on the east and west sides. A gable-roof house is best adapted for a long brooder house. There should be liberal lighting. The alleyway should be about 20 inches lower than the hover floor, to facilitate cleaning and to afford room for the hot-water pipes. The water is kept at practically constant temperature by means of automatic regulation of drafts. In addition, the amount of heat allowed any compartment can be controlled by dampers in the pipes.

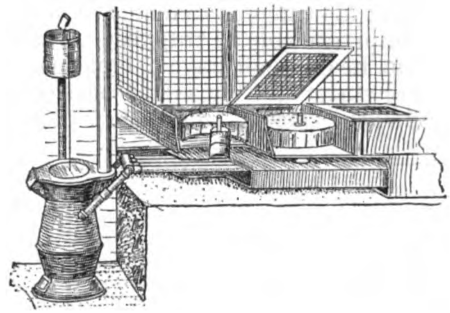


FIG. 592. Details of a modern hot-water brooding system. One hover is cut away to show how the warm air from the pipe box is liberated above the chicks' backs. Note the air space above the pipe box to prevent the floor from getting too hot.

**The colony house.** Farm poultry keeping is quite largely a colony-house method. Usually, the entire flock is kept together, and one house is used. Commercially, the colony-house system has been employed in the raising of young stock by means of portable houses. For housing mature fowls, the system is being extensively used in Rhode Island, where it is called the "Little Compton" system of poultry farming. Briefly speaking, the plan employed is this: The colony houses are comparatively small and portable. They are scattered over the fields, which may be cultivated. The poultry flock enters into the system of crop rotation, usually following the hay crop. In this way, birds run on the same field only a year at a time and at intervals of 3 or 4 years. The advantages of this system are: (1) conditions favorable for chickens; (2) economical feed cost; (3) improvement of the land through added fertility; (4) less danger of soil contamination; and (5) outbreaks of disease can be more easily controlled. Colony-housed stock does not require so many precautionary measures as that kept in long houses; for the more closely chickens are confined, the greater amount of work necessary to keep conditions sanitary. The disadvantages of such a system are: (1) added labor in bad weather, it being disagreeable for the caretaker to go from house to house; (2) it frequently requires more fencing, if colony houses are sta-

tionary; (3) the poultryman will not make as close a study of individual birds, as it is impracticable to trapnest his stock; and (4), where flocks are permitted to mingle, he does not have complete control over matings.

For stationary houses, the size of the unit may be as large as suits the individual poultry keeper. The colony houses described on a previous page are for 100 hens. The Yesterlaid Farms at Pacific, Missouri, are using a colony house 30 by 60 with 2 floors, housing 1,000 birds to a house.

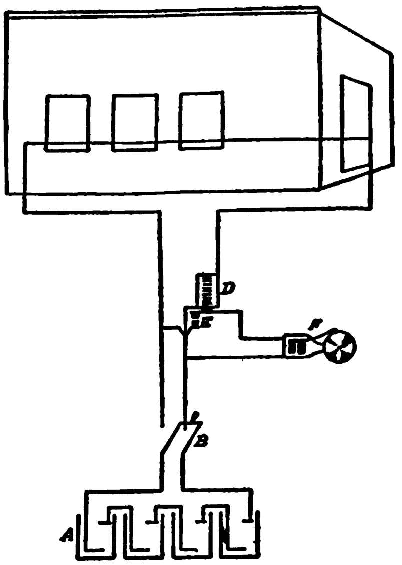



FIG. [illegible]93. An electric burglar alarm on the poultry house is a good investment. In this plan the switch (B) is closed at night thus completing the circuit through the wiring and batteries (A) but not through the bell (F). If the circuit is broken by the opening of a door or window in the hen house, the magnet (D) releases the armature (E) which springs over, closes the bell circuit and alarms the household.

**Long houses.** Long houses for poultry keeping are representative of what is known as the intensive system. This type necessitates restricted yards and extensive fencing. It is primarily adapted to the housing of laying stock. The advantages of such a system are favorable conditions during inclement weather for birds and attendant, convenience for the caretaker in the daily routine, and economy of land. The disadvantages are yard contamination, increased cost of fencing, and extra labor in caring for the yards. The long house is a commercial proposition.

A good type of house of this kind is the "Commercial" poultry house which is 18 x 180 feet, with a feed house at the end. It is divided into pens 18 feet square and will house 700 hens. The front is 7 feet 8 inches high, and the back 4 feet 8 inches. The roof is of unequal spans, the front span being one half the length of the back span. The roof is comparatively steep, having 1 foot rise to 2 feet horizontal run. The pens are connected by a series of doors, thus compelling the poultryman to mingle with the birds where he is able to study their needs more carefully.

The cloth-front type of ventilation is used in this house. In the centre of the south side of each pen is a glass door made by hinging two 9-light 9 x 12-inch windows, thus affording a door which can be opened for cleaning purposes. On both sides of the door are cloth frames 3 x 5 feet. These are placed 4 feet from the floor and, when open do not allow drafts on the birds. At night, there are no drafts on the birds, because the frames are closed. No matter how cold the weather, at least one of the frames is opened every day, unless there are storms from the south. The arrangement of droppings platform, perches, and nests follows very closely the instructions given above under "Interior arrangement." The roosts are set on 2 x 4-inch pieces in the form of a frame, which is hinged at the back and may be raised, thus rendering the droppings platform easily accessible for cleaning. Often, it is desirable to raise the roosts, so as to force lazy hens off them to the floor.

The cost per hen of materials for such a house will be practically the same as for the colony house.

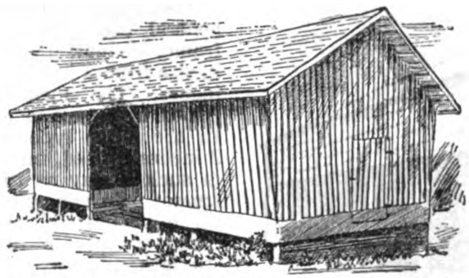


FIG. 594. A well-built corn crib of the common slat type. This is better than those found on many farms, but unless protected against rats and kept in repair, it may permit considerable waste.

# CHAPTER 36

# Storage and Work Buildings

*By* PROFESSOR K. J. T. EKBLAW *(see Chapter 31). Like all manufacturers, the farmer has to provide for the storage of his raw materials, his implements and tools, and, to some extent, his finished products. He is at a disadvantage, however, in that these vary greatly in bulk, weight, nature and condition, and consequently require several types of structure. Futhermore, they are sometimes of comparatively small value, in proportion to their extent; wherefore their shelter cannot be of too expensive a type. Professor Ekblaw discusses here some of the principles to be kept in mind in the construction of adequate but practical and economical storage buildings. The second group of structures referred to in the chapter title consists of those in which the farmer works over his raw materials and products, with the exception of those in which his "machines", that is, his livestock, are kept and fed. These have been covered in Chapters 34 and 35.*—EDITOR.

IT IS undoubtedly the fact that too often the construction of the storage and work buildings on a farm does not receive the careful consideration which its importance claims.

The questions of location, size, material, and interior arrangement should all be thoroughly thought out, so that needless expense may be avoided, and the greatest amount of usefulness secured from the several buildings. These buildings usually include some or all of the following: hay barn, granary, implement shed, milkhouse, creamery, and cheese factory.

## Hay Barns

The purpose of a hay barn is to provide shelter for hay and facilities for curing it under the most favorable conditions. One of the first requirements is ample ventilation. With the ordinary barn, the freedom of the circulation of the air is so great that no especial provision for ventilation need be made.

Primarily a hay barn is simply an inclosed shelter; and, since the load of the contents does not come upon the structure itself to any extent, the building should be designed mainly to resist wind pressure, both external and internal. The interior of the structure is of necessity rather open, to admit of the unhampered handling of the hay. Open framing precludes the use of crossties braces, the which, in many other structures, greatly strengthen the framing; to overcome lack of strengthening frame members, great care must be exercised in the design.

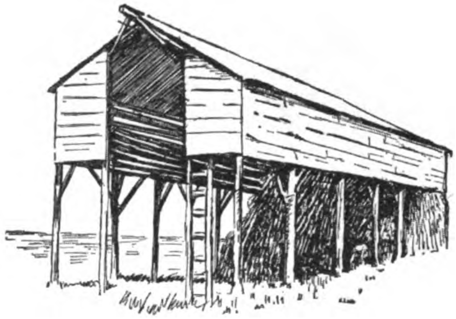


FIG. 595. A common type of hay barn in regions where comparatively little wet, stormy weather is encountered

**Location.** The hay barn may be located either as one of the buildings of the farmstead or as a separate building in the hay field itself. It may be advantageous to have the hay stored in close proximity to the feed lots; but, in many cases where hay is the main crop on the farm, it is not fed, but is marketed; and then, of course, it is not necessary to store it in any place other than in the field.

**Size.** The size of a hay barn is governed by the amount of hay to be stored and by certain structural limitations. Ordinary loose hay will occupy approximately 500 cubic feet per ton; when packed, this will be reduced by 50, 75, perhaps even 100 cubic feet. With timber framing, it is possible to make barns as wide as 48 or 50 feet; anything above this is not practicable. With the plank frame, it is possible to make the trusses more than 40 feet wide; but it is not advisable, on account of the difficulty of securing adequate bracing when the framing is made sufficiently strong. Such circumstances require the use of an unduly large quantity of material which renders the cost excessive.

**Construction.** Since the framing of the barn is built up from the ground, it is unnecessary to have a continuous foundation. The frame consists, usually, of built-up units, sometimes called "bents," which are from 10 to 14 feet apart and are supported at the sides upon masonry piers. These should have footings large enough to carry the weight of a half of a bent and the portion of the walls and roof which is supported by it. On ordinary soil, a load of approximately one ton may be allowed per square foot of footing.

Two types of framing are in more or less general use. One, known as the "timber frame," is built up of pieces of timber varying in size from 4 by 4 inches to, perhaps, 6 by 8 inches. The members of the frame are joined by means of mortise-and-tenon joints. In the other type, no lumber thicker than 2 inches is used, but the pieces are combined in such a way as to form strong and rigid trusses. In general, the latter type is much the more desirable, since it is economical of material, admits of careful designing for strength, and leaves the interior open.

**Walls.** It is common practice to cover only a portion of the sides of the building. The lower half of the walls may well be left open; and, in fact, many barns are built with no wall covering. However, this is hardly to be recommended, because an undue amount of the hay is exposed to the weather. Plain 1-inch siding, 10 or 12 inches wide, nailed to 2 by 6-inch girts at 5-foot intervals makes an entirely satisfactory wall. The covering of the cracks with ogee battens is optional.

**Roof.** Wooden hay barns, as well as other types of barns, are ordinarily made with a gambrel roof, sometimes erroneously called a "hip" roof. The main advantage of the gambrel roof over the ordinary straight-pitch roof is that it permits of the arrangement of the truss members to produce maximum strength; besides this, it affords much more mow space (Fig. 597 inset.)

The covering of the roof may be either of wooden shingles or of shingles made of prepared roofing. Prepared roofing itself is not a desirable material to use on a gambrel roof, because the lower section of the roof is

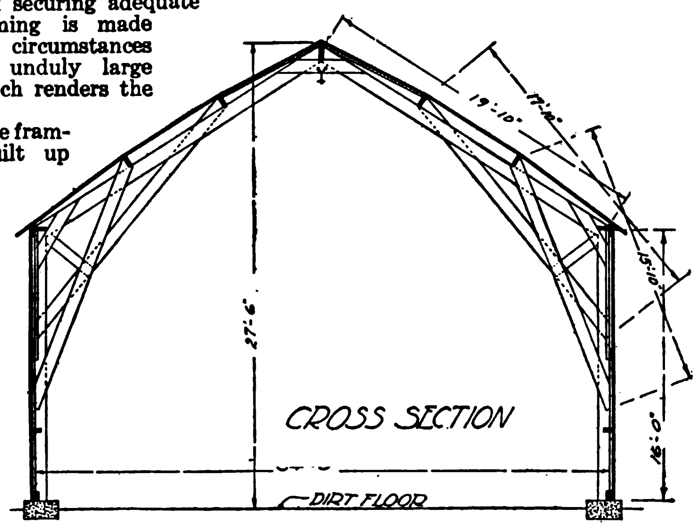



FIG. 596. Section of a barn built on the straight-pitch, braced-truss principle solely for hay storage. In northern sections building material is saved and greater protection given to the stock by storing hay in the upper part of the horse and cattle barns.

very steep-pitched, and such roofing has a tendency to sag, when used under such circumstances.

**Equipment.** It is possible to obtain hay barn equipment in such complete and careful designs that practically no manual labor is involved in the handling of the hay. If a hay barn is built in the field, the hay can be brought in from the windrow directly to the barn, there hoisted, and transported to almost any portion of the barn. The equipment within the barn usually consists of a central longitudinal track suspended from the roof at the ridge. A carrier, to which is attached the swing or the fork, runs upon this track; and, when the swing or fork is loaded, the hay is moved either by horsepower or by means of an engine-operated hoist.

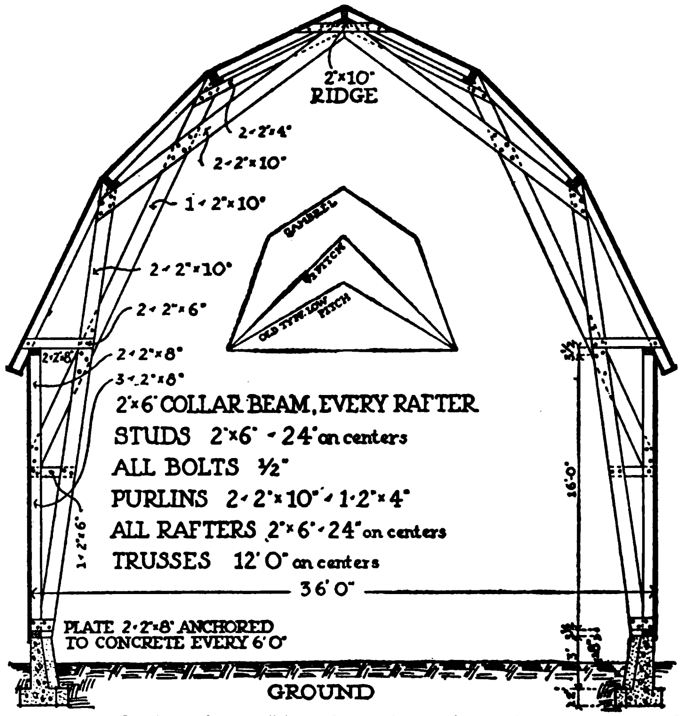



FIG. 597. Section of a well-braced hay barn of the double-gambrel roof type, built on a secure concrete foundation. The inset shows the space gained for storage by using a gambrel roof rather than the single high- or low-pitch type.

The hay barn is quite often an isolated building, and for this reason should be provided with adequate lightning protection. It is claimed that the vapor arising from hay that is going through one of the stages of curing, known as the "sweat," acts as a conductor of electricity. Such claims have never been fully substantiated. Nevertheless, the lightning-rod equipment should be carefully designed, and every sharp ridge or corner should be protected by conductors. The aërial terminals should be of some non-corrosive material and should be placed at intervals not exceeding 25 feet. The lower end of the conductors should be well grounded by means of a soldered connection with a galvanized iron pipe extending far enough into the soil to reach the level of permanent moisture. A better but more expensive ground is made by connecting the conductor with a metal plate, buried 5 feet in the earth, and encircled by a bed of charcoal which is retentive of moisture.

## Granaries

The term "granaries" should include all structures which are used for the storage of grain. Common usage sometimes limits the application of the term to such buildings as are tightly walled, and in which are stored only the so-called small grains. Corn is commonly stored in a building called a "crib," whose walls are more or less open, in order that some ventilation may be afforded.

The granary is a farm building whose requirements are somewhat peculiar. The building must be designed to resist not only vertical loading, but lateral pressure as well; for small grain acts, to a certain extent, as a fluid, and its lateral pressure is sometimes very great. A number of investigators have conducted experiments to determine the bottom and side pressure of grain bins of various kinds. Their general conclusions are that the lateral pressure is from 30 per cent to 60 per cent of the vertical pressure and that neither of them increases

to an appreciable extent, if the depth of the bin becomes greater than 2½ or 3 times the diameter or width. Both the lateral and the side pressure depend, to a certain extent, upon the weight and the character of the grain. The failure of many granaries is due to the fact that proper consideration is not given to the lateral pressure, which at the bottom of the bin may be very great; and, as a result, the walls are burst out at this point, leaving the superstructure of the building practically unsupported, while the whole structure becomes racked and twisted.

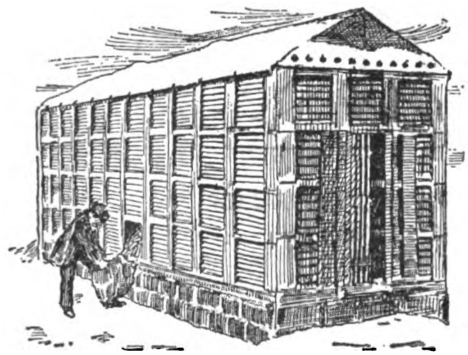


FIG. 598. A hollow-tile corn crib that is weather-, rat-, and fire-proof, and in the long run no less expensive than a more temporary type.

**Location.** In the majority of cases, the granary is located at the farmstead, since much of the grain is fed, and that portion of it which is marketed can be taken just as easily from such a location as from one in the field, where it would probably be occupying valuable ground. Granaries containing feed for livestock should, of course, be built near the feed lots. It is always well to provide ample space around the building, to allow of the free handling of teams.

**Size.** The width of a granary for small grains depends entirely upon the design of the building. Small grains are likely to heat, especially when first stored, and for this reason cannot usually be stored for any great length of time without some resulting deterioration in the quality of the grain. Common sense would indicate that 12 or 14 feet is a reasonable width for structures of this kind. For ear corn, the width of the crib is dependent upon the climate. In the heart of the corn belt, the common practice is to make the cribs 9 feet wide. Farther east, it is necessary to reduce this to 8 feet or even to 6, while in the western corn-raising states it is found practicable to increase the width to 10 feet without any damage resulting. The reason for thus adjusting the width to the climate is that the corn, when first husked, is somewhat damp, and, unless provision be made for rather rapid drying, it will rot. The drier air of the western states permits the use of wider cribs.

The height of the granary is variable. If the grain is to be unloaded into the building by hand, about 12 feet is the maximum, but, if elevating machinery is to be utilized in unloading the grain, the height may be any desired. On farms where great quantities of grain are to be stored, it is quite common to find cribs that are 16, 20, or even 24 feet high at the eaves. With the ordinary interior portable elevator, perhaps 16 feet should be the limit; but, with interior elevators installed as permanent equipment, great depth of bins is not only practicable, but desirable, since the additional capacity is obtained simply by putting on additional wall material, the same roof and floor serving for a high building as well as for a low one.

It is well to make the length of the granary such as to admit of the use of standard lengths of lumber, though this requirement does not hold where other types of building material are used. When lumber is the material employed, a practical unit length is 16 feet, and the crib may be made up of as many unit lengths as desired.

**Shape.** On small farms, a simple rectangular building is, perhaps, the best. The roof may be of the shed type or of the ordinary gable type, the former being the simpler. Double granaries are made by building 2 single granaries a few feet apart and extending the roofs so as to cover the open space between, which forms a sort of passageway. This scheme has been elaborated until what has become almost standard construction on large grain farms is a building consisting of 2 corncribs with a driveway, 10 to 14 feet wide, between them. At a height of about 10 feet the driveway is floored over with tight flooring, and the upper portion of the inclosure is used as storage for small grain.

**Construction.** The foundation of the granary must support not only the weight of the superstructure itself, but a large part of the entire load of the inclosed grain. The vertical load upon the floor in deep bins is very great, while the weight of the superstructure is perhaps not excessive. The load due to the friction of the grain on the walls is transmitted to the foundation, and this additional load is, perhaps, greater than the weight of the superstructure itself. This can readily be understood when it is explained that grain in a bin forms a sort of an arch in settling, and that the portion of the grain above a height equal to 2½ or 3 times the diameter is supported mainly by the friction upon the side walls.

The foundation should be a continuous wall extending below the frost line and should have a footing not less than 18 inches in

width. In high buildings the footing should be 24 inches wide. The floor may be of ordinary sill-and-joist construction, but a concrete floor is generally to be recommended. It should be not less than 6 inches thick, and, when properly made of a rich mixture of clean materials, it is practically waterproof. The floor should slope to the rear of the bin, so that drainage may be provided for any excessive storm moisture which may accidentally gain access to the interior.

**Framing.** It is essential that the framing of the crib be very strong, if the building is to be at all durable. Vertical studs not less than 2 by 6 inches should be located at intervals varying from 18 to 30 inches, depending upon the depth of the bin and the amount of lateral pressure produced. These studs may be toe-nailed to a plank sill which, in turn, is anchored to the foundation; but a better plan is to use studding sockets, imbedded in the concrete, which are made to receive the ends of the studs and afford a firm and secure fastening. The studding sockets avoid the inconvenience and difficulty caused when it is necessary to replace the plank sill. In fact, if the end of the stud be treated with some wood preservative, no replacing is likely to be necessary before the whole structure shall have fallen into decay.

The framing over the driveway must be exceptionally strong, especially if the driveway is a wide one. It may be necessary to double the studs up to the small-grain-bin floor, and the joists extending across should be carefully designed, so that there may be no danger of bending and collapse. It must be borne in mind that grains such as wheat and rye are quite heavy and that a load of many tons is put into the bin.

The wall covering for structures containing small grains must, of course, be tight. The material that is ordinarily used is either shiplap or drop siding, the latter being preferable. For covering the sides of corncribs, ordinary 1 x 6 boards are entirely satisfactory and should be applied with a 1-inch space between adjacent boards. A special siding is made in which the edges are beveled; this affords just as great an amount of opening in the walls, but the overhanging bevel assists in preventing storm water from being driven into the crib. Slightly more material is necessary when beveled siding is used than when plain boards are employed.

**Roof.** In combination cribs such as have been just described, steep-pitched roofs of not less than half pitch are the rule. It can readily be seen that the steeper the roof, the greater will be the storage space underneath and the greater the space afforded for the installation of conveying equipment, which is an essential part of the modern granary. The roof covering may be either of wood or asphalt shingles.

**Ratproofing.** The question of ratproofing

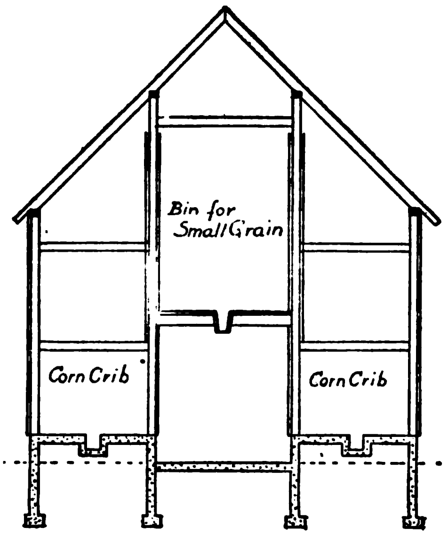



FIG. 599. Section of a combined corn crib and granary that could advantageously be equipped with a grain elevator (Fig. 551)

a crib is an important one, since an immense amount of grain is damaged or destroyed annually by rodents. A very efficacious method of ratproofing, described by the United States Department of Agriculture, is as follows: A heavy galvanized wire screen of quarter-inch mesh and about 28 to 30 inches wide is nailed on the outer edge of the studs before the siding is applied. This is brought down close to each corner, and effectually prevents the admission of rodents under the space which is covered. To prevent the animals from climbing above this space, a strip of galvanized iron is tacked on around the exterior of the building, on the outside of the siding, at the same height as the top edge of the galvanized wire screen. This strip is about 8 inches wide, and positively prevents any rats from crawling up the side of the crib, since they can obtain no foothold upon the metal. The strip should extend around the entire outer boundary of the crib, covering walls and doors, as any unprotected spot entirely destroys its value. Of course, no objects such as a board, neck-yoke, or anything upon which a rat could climb, should be left leaning against the crib to provide a pathway for the animal.

**Equipment.** The modern development of grain-handling equipment has brought into use some exceedingly ingenious and convenient apparatus, and the old, laborious method of shoveling grain has been rendered entirely obsolete. Grain brought to the granary is dumped into elevators, by which it is carried to the top of the crib, and thence, by means of horizontal conveyors or flexible tubes, is delivered into any desired portion of the struc-

ture. The exterior portable elevator has an inclined conveyor, which may be supported upon the roof of the building with its upper end extending over an opening provided in the roof. This opening is usually covered with a cupola or trapdoor. Where all the grain produced on a farm is stored in one building, a permanent vertical elevator with accompanying horizontal conveyors may be installed. In the case of the elevated bin, provision for emptying it may be made by simple valves in the bottom. In corncribs, a trough extending the length of the crib is constructed in the floor. When the bin is filled, this trough is covered with boards; and, when it is desired to empty the bin, a conveyor is slipped into the trough from one end of the bin, so that the grain may run by gravity into the conveyor and by it be carried away.

## Implement Sheds

Many farmers do not realize that much of the deterioration of their machinery and implements is due to insufficient protection from the weather and to lack of proper care. It has been found in the case of somewhat expensive machines, as the grain binder, for instance, that the average life is but 5 years, whereas with proper care it should be at least 15 years. It has been estimated that the cost of proper implement sheds would be saved in 4 years by this prolongation of the life of machines. The importance of these buildings to the farmer will thus be readily seen.

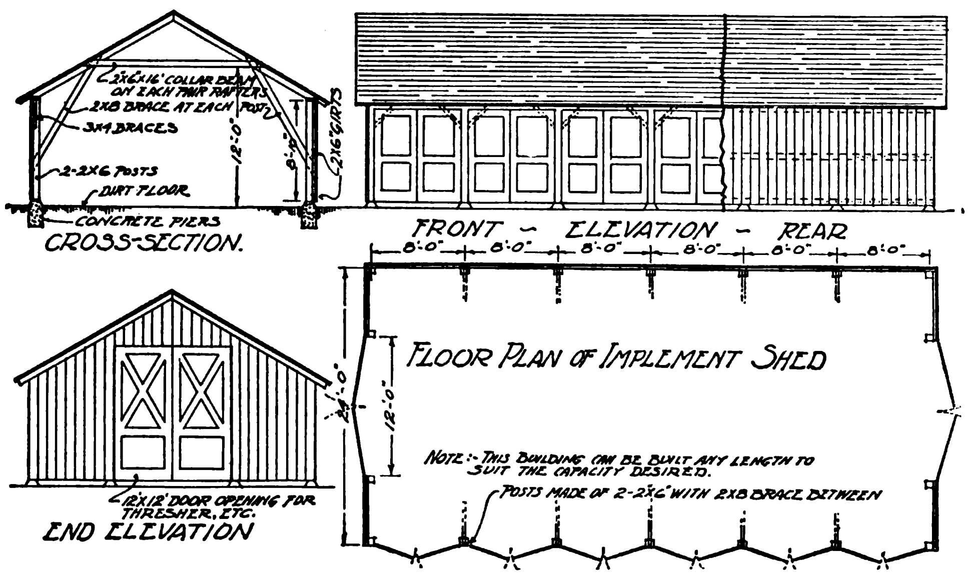



FIG. 600. Plans and dimensions of an implement shed that can save many times its cost in the increased life it gives to the machines kept in it

**Location.** The location of the implement shed is the first point that the prospective builder should consider, since, in the natural course of farm work, the horses are taken from the barn, hitched to the implements, and then driven to the fields. It follows that the implements themselves should be kept in some place which is intermediate between the barn and the fields. The direction of the prevailing wind must also be taken into consideration, in order that the doors may, as far as possible, be located on the leeward side. The garage is sometimes connected with the implement shed; consequently, it is usually desirable to have the location not too far from the dwelling. If a repair shop or a power plant be incorporated in the same building, the same recommendations would apply.

**Requirements.** Since the building is designed primarily as a simple shelter, and no part of it, except the floor, is subjected to any great load, it is necessary in designing the superstructure to make it only strong enough to resist snow and wind loads. The interior

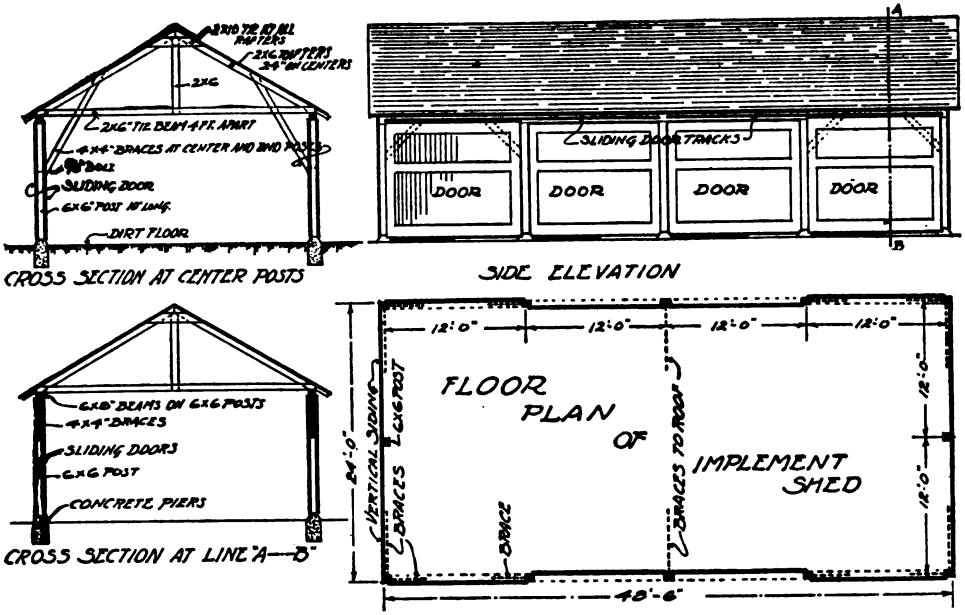



FIG. 601. This shed has greater depth than that shown in Fig. 600, and sliding doors which often work more freely than hinged ones. Light implements and parts can be stored on the rafters, whether floored over or not

should, if possible, be kept free from supporting posts, in order that there may be the minimum interference with the arrangement of implements. The building should not be too narrow and its length not so great as to produce an awkward appearance in the structure itself.

**Materials.** Probably the best material for the construction of an implement shed is wood, although, where a large number of machines are to be sheltered and where a heavier investment is warranted, it may be found advantageous to use some of the more permanent building materials such as brick, hollow clay blocks, or concrete. Since simplicity and economy are the fundamentals of construction, it is doubtful if the average implement shed justifies the use of the more expensive permanent materials. The floor of the shed may be made of concrete for the sake of durability; but it is expensive, and sometimes dulls the sharp edges of certain cutting implements which may be run over the floor. A wooden floor has neither of these disadvantages; but, on the other hand, it is subject to decay, particularly so since it is usually preferable to construct the floor rather close to the ground.

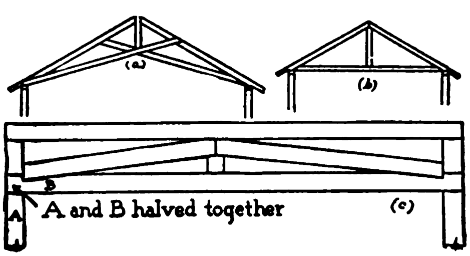



FIG. 602. Simple roof framing for machine sheds (*a* and *b*) the latter providing extra storage space; and (*c*) one style of trussed lintel for a wide shed door.

**Size.** Experience has shown that, on the average farm, sheds 18 feet and 25 feet in width are most advantageous in the placing of machines; and both of these widths are such as to admit of the economical use of standard lengths of lumber. Of course, any variation from these figures is permissible, if a better arrangement can be secured thereby. The length can be adjusted to meet the required floor space, although the general proportions of the building must be kept in mind for appearance sake.

It is usually advisable to build an implement shed of one story only. The use of a 2-story structure is ordinarily not advantageous, since either a hoist or a ramp must be utilized in getting an implement into the second story, and both devices are likely to be unsatisfactory and difficult to operate. Under some circumstances, however, as, for instance, when the shed is built on the slope of a rather steep hill, it may be possible to gain access to the second floor from the slope above the building, while the first floor may be entered from the slope below, as is very often the case

in bank barns. If a 2-story building is erected, care must be taken to design the framework so as to withstand the extra loading which is placed upon it. The usual arrangement in a building of this kind results in the placing of the lighter and more easily handled machines in the upper story.

**Interior arrangement.** The interior arrangement of the machine shed will depend, to a great extent, upon the particular use to which the building is to be put. If it is to be used simply as an implement shed, a rectangular building with a free interior will be the most desirable. If a shop or power plant be added, it may be placed in an extension of the building at one end, the same arrangement holding good if the building is to include a garage. However, too many extensions in one direction are likely to make the building unduly long; consequently, it may be well to make some of the additions in the form of wings or ells. Where local requirements are important, the position of the garage or the repair shop may properly govern the arrangement.

In planning a machine shed, the natural procedure is to make a list of the various implements to be housed, to ascertain their space requirements in width, length, and height, and then to determine the total floor space required. Considerable economy of space may be effected by using care in the arrangement of the machines. For instance, spike-tooth harrows may readily be disposed of by hanging them upon the wall. Small hand tools, walking plows, drills, and so forth may be slipped into the corners between other machines. In this way, the total floor space required may be reduced as much as 10 to 15 per cent.

When making a tentative arrangement of the machines within the designated area, the natural sequence in which they will enter into the farm operations, as well as the number of times per year they will be used, should be kept in mind. For instance, a binder that is used but once a year may well occupy a corner farthest from the door, while a mower, being used more or less throughout the entire season, should be placed next to the door, where it will be readily accessible. Implements like wagons and spreaders are used to such an extent that it is advisable to keep them in a place where no time will be lost by having to take them out of and put them into a shed. When so disposed of, they may be drawn by the horses directly under the shelter and left there when the horses are unhitched. Similarly, no time will be lost when the implements are used again.

A repair shop or a power plant built in connection with an implement shed usually requires a little better construction than in the shed itself. The repair shop is likely to be used during wintertime and, consequently, must be heated. It follows that the walls must be built tight and should be insulated, in order that the waste of heat be not too great. Ample light must also be provided, which necessitates the use of several windows. Such a room must also be ceiled. A plan that may be followed to good advantage, if a seed storeroom be needed, is to make a 2-story structure, with the workshop below and seed storeroom above. While the seed room should have a tight floor, any loss of heat through the workshop will only add warmth and dryness to the storeroom above. A garage in connection with the implement shed should be so located that there will be a door between the workshop and the garage, thus making possible the utilization of the same heating unit in both rooms.

An addition to the main part of the shed

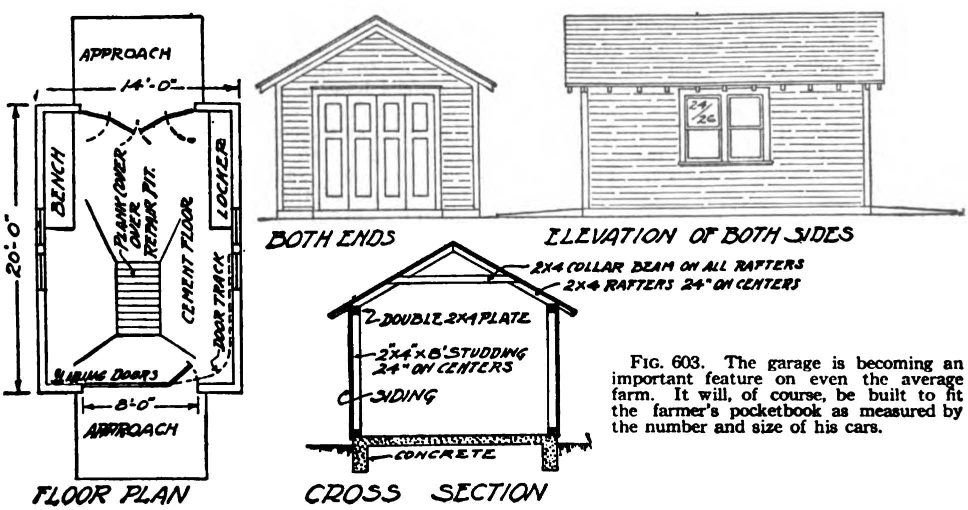



FIG. 603. The garage is becoming an important feature on even the average farm. It will, of course, be built to fit the farmer's pocketbook as measured by the number and size of his cars.

is often provided for such implements as wagons and spreaders, consisting simply of a roof supported on posts 9 feet apart. The wagon or spreader is driven under this structure and the horses are then unhitched, leaving the implement where it stands. Quite often, the implement is kept under separate cover near the barn, where the litter carriers may be emptied directly into it.

**Framing.** Two methods of framing may be followed, depending upon the type of wall covering that is to be used. In one method, 6 x 6 posts, set upon concrete piers with 4 x 6 plates on top, form the main part of the frame. On the outside of the posts, at the top, bottom, and middle, 2 x 6 girts are cut into the posts, flush with the outside surface. These provide a nailing for the wall covering which, in this case, consists of 1-inch boards, usually 10 or 12 inches wide, placed vertically, the cracks between the boards being covered by ogee battens.

If it is desirable to have horizontal siding, it will be necessary to use, instead of the posts, 2 x 6 studs 2½ or 3 feet on centre, the 4 x 6 plate being placed on top of these. In regions where the wind is never severe, it may be possible to use 2 x 4 studs, but such a procedure is likely to weaken the structure greatly.

Some objection to the use of horizontal siding has been made, on the ground that the horizontal joints between the boards are likely to retain moisture and thus cause early decay. The joints between vertical boards are self-drained.

If the heavy post framing be employed, the only foundation required will be the supporting piers; but, if the alternate method of framing be used, it will be desirable to have a continuous foundation wall, which need be only 6 inches wide and, perhaps, 2 feet deep; for no great weight comes upon it.

**Roof.** The rafters supporting the roof must be strongly self-braced, since the presence of interior supporting posts makes the handling of machines difficult in a shed less than 18 feet wide. A simple crosstie, with a king-post at the centre, is usually sufficient; but in wide buildings it may be necessary to utilize some sort of a simple truss, to prevent sagging of the roof.

The roof covering may be either shingles or prepared roofing. In the first case, the roof sheathing consists of 1 x 4 boards spaced 2 inches. In the second case, it will be necessary to use close sheathing. Shingles should not be used on roofs of less than one fourth pitch, for on roofs of low pitch they are subject to rapid decay, due to slow drying.

**Doors.** In a building of this kind, there should be as few doors as possible. In a small machine shed, one door is usually sufficient; but this will have to be rather wide, in order to accommodate such machines as rakes and wide drills. In some arrangements of sheds, it may be found desirable to have one entire side equipped with doors; but extra doors always increase expense, not only in first cost, but in maintenance as well. Swinging doors wider than 4 feet should not be used, on account of the difficulty of securing adequate supports for the hinges. Even with good supports, the weight of the door will often cause it to sag.

Since it is usually not practicable to have the main door less than 10 or 12 feet wide, it follows that the plate above the door must be extra strong. It may consist of three 2 x 10's nailed together on edge, or of a simple triangular truss whose rise is not more than one foot in the entire span.

## Milkhouses

The primary purpose of a milkhouse is to provide a place in which the milk may be properly taken care of immediately after milking. Experience has shown that quick cooling after milking prevents the growth of bacteria, for warm milk is an almost perfect medium for bacterial growth. Also, the flavor of milk is improved by quick cooling. The milkhouse should be kept separate from the barn, in order that the milk may not absorb odors from the silage and manure. Since it is necessary that the utensils used in milking be kept clean, an excellent place in which this may be accomplished is the milkhouse.

**Location.** The location of the milkhouse may be either near the barn, or, as is commonly the case with small dairies, nearer the house than the barn. Much will depend upon who has charge of the care of the milk. In certain localities, where springs or running artesian wells are available, the location of the milkhouse may depend upon the accessibility of the water supply, because a supply of running water is such a decidedly good feature that the fullest advantage should be taken of it. Since the building is usually rather small and inconspicuous, in comparison with the rest of the farm buildings surrounding it, it usually does not obtrude itself upon the view; consequently, no matter where it is placed, it is not likely to prove an undesirable factor in the general appearance of the farmstead.

**Size.** The size of the milkhouse will depend mainly upon 2 things, namely, the size

FIG. 604. This kind of milk house brings neither satisfaction nor profits—

of the herd and the method of disposal of the product. On the ordinary farm, where only a few cows are kept, a building of 100 to 150 square feet of floor space will be amply large. The size of the building may be increased as much as desired to accommodate a greater production of milk. If the product of the cows is sold as whole milk, a smaller building will be needed than when the product is sold as cream or butter; for, in the latter case, additional provision must be made for accommodating additional equipment, such as a cream separator and a churn. The building is almost always of one story only, sometimes partially below ground, an arrangement which renders excellent drainage imperative.

**Arrangement.** A typical arrangement for a milkhouse of a rectangular shape is to have it divided into 3 sections, one being partitioned off to provide a washroom for the milkers and one as a room for the cleansing of the milk utensils. The second section accommodates the boiler and provides space for the storage of fuel. The third section is the milkroom proper, and is usually located between the other 2 sections. Provision must, of course, be made for ample light and adequate ventilation, since both of these are valuable sanitary influences.

**Equipment.** The method of disposing of the dairy product will naturally control the amount and variety of equipment installed in the structure. If the owner sells the milk, it will be necessary to have a cooler, which usually consists of a vat, or tank, provided with running water of a temperature not exceeding 50 degrees or which may be kept at that temperature by adding ice to the water. Very often springs furnish water which is of itself sufficiently cold; but, if this cannot be had, and ice must be provided, it will be necessary to include in the milkhouse some arrangement for ice storage. If the milk is sold in bottles, some additional equipment in the way of a sterilizer, a small bottler, and a refrigerator for the storage and rapid cooling of the bottled milk is necessary.

FIG. 605.—This kind of milk house brings both

When cream is sold instead of the milk, the cream separator is an essential item of equipment, and the wise dairyman will include a Babcock tester. When the cream is churned into butter before being sold, a churn is, of course, necessary; and, if the amount of butter produced is at all extensive, some sort of power for operating the churn and some of the other machinery will be required.

The washroom for the milkers should be provided with sanitary lockers for their clothes, and a lavatory and a shower bath would be decidedly advantageous. In that portion of the room given over to the cleansing of utensils, the equipment should include a large sink so set that not only may a supply of water be available for it, but steam, also, for sterilization of the utensils. There should also be installed a slotted rack of adequate size upon which the utensils may be placed for draining after having been thoroughly cleansed. In many milkhouses, a closet is built between the washroom and the milkroom, into which the utensils, after cleansing,

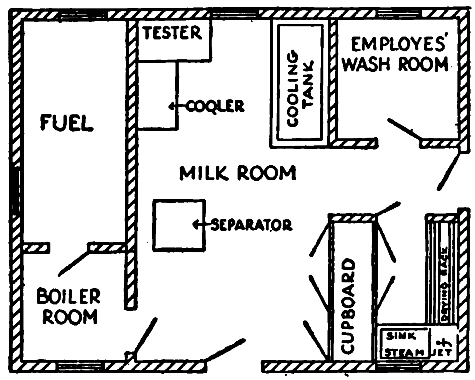



FIG. 606. Floor plan of a small milk house adapted to the needs of a general farm carrying on a moderate dairy business.

are put from the washroom side, being taken out as needed through doors on the milkroom side.

The boiler room need not be very large, since the only thing to be placed in it is the vertical boiler of 2- to 5-horsepower, which will furnish the steam and hot water necessary for cleansing purposes. The fuel room should be large enough to contain a suitable amount of fuel. In most regions, the fuel will consist of coal, the use of which is accompanied by dust and dirt; but certain sections of the country are especially favored with natural gas or with crude oil, either of which provides a very cleanly fuel.

**Construction.** In a small building of this kind, a very simple foundation, consisting of a continuous wall extending below the frost line and with a footing not exceeding 1 foot in width, is all that is necessary. It will be advantageous to have this foundation of concrete and to make it practically continuous with the floor which should also be of con-

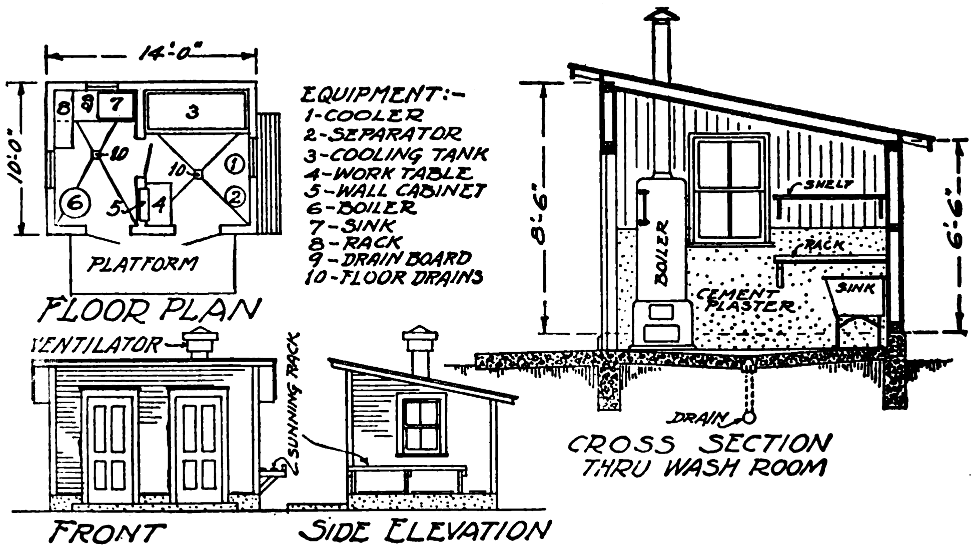



FIG. 607. Plans of a two-room milkhouse equipped with a boiler for washing and sterilizing

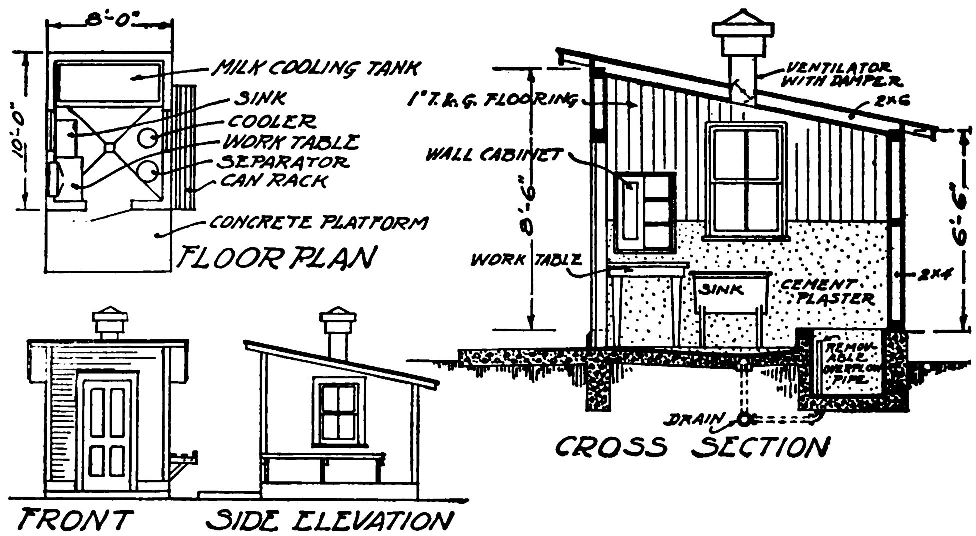



FIG. 608. Plans of a small one-room milkhouse in which milk and cream for a limited local trade can be handled promptly and in a sanitary manner

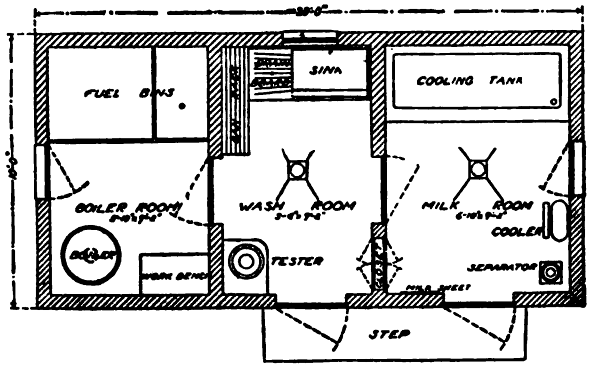



FIG. 609. Floor plan of a larger, more complete dairy house including a boiler room which can be used as a shop

crete. There may be some objections to this material because it is so cold and so hard to walk upon; but any such objections are more than counterbalanced by the sanitary value possessed by concrete, since it may be readily kept clean. The floor should not be made perfectly level, but should be provided with a drain toward which the entire floor should slope.

The superstructure may be of wood, in which case the studs are attached to the foundation by the use of stud sockets. Normally, wood will be the cheapest material; but, for the sake of durability and sanitation, it may be found desirable to build practically the entire structure of concrete. There are on the market various forms of metal wall reinforcing which may be combined with concrete so as to form a wall sufficiently strong and substantial for a building of this character. The inside walls, whether of wood or cement construction, should, of course, be kept as smooth as possible.

It must be borne in mind that sanitation is the keynote in the construction of any kind of dairy buildings; for recent careful investigations indicate that contamination of milk occurs to a greater extent in the handling of the milk after it comes into the milkhouse than in the barn itself.

## Creameries

These buildings are found almost entirely in regions which are primarily fitted for dairying, although occasionally a creamery may be located in regions of general farming where the transportation is good. Indeed, the ideal situation for a creamery is in the centre of a good dairy production community, with good roads and good facilities in the way of railway transportation. It must be remembered that, usually, there is an investment of several thousand dollars in buildings of this kind and, since they are generally owned by a number of individuals, or stockholders, it is necessary to have some assurance of profits in order to satisfy the numerous owners.

**Location and requirements.** As far as local conditions controlling the location are concerned, the building must be away from dust and dirt, which means that it should be protected by some sort of a windbreak, if possible, and should be some distance away from the road. An adequate supply of water is essential; this must be obtained either from springs or from wells. There must also be opportunity for the disposal of waste and sewage, which, in the case of dairy buildings, is especially difficult to handle. If an adequate supply of running water is not available, it will be necessary to store considerable quantities of ice; and, for this reason, the presence in the vicinity of a body of good water, from which ice may be harvested in winter, is a decidedly advantageous feature. Of course, the cooler the natural water supply, the less the ice that will be needed.

**Arrangement.** It is difficult to enumerate any definite principles which should control the arrangement of a creamery. In general, however, it may be said that a refrigerator is a necessity and that its natural location should be at the north end, since this is likely to be the coolest part of the building. Storage rooms will, of course, be needed in close proximity to the refrigerator and, consequently, the whole north end of the building may be given over to refrigerative operations. The intake for the purchased dairy products will, normally, be at the other end of the building and, usually, will occupy a considerable space. An exterior unloading platform, about 4 feet from the ground, should be provided, and a portion of the floor within the building should be built up to the same level; by this arrangement it may be possible to utilize gravity, to some extent, for conveying the raw material to the other parts of the plant. When cream or milk is purchased, it, of course, must be tested for butter-fat content. This requires a testing room, which should be

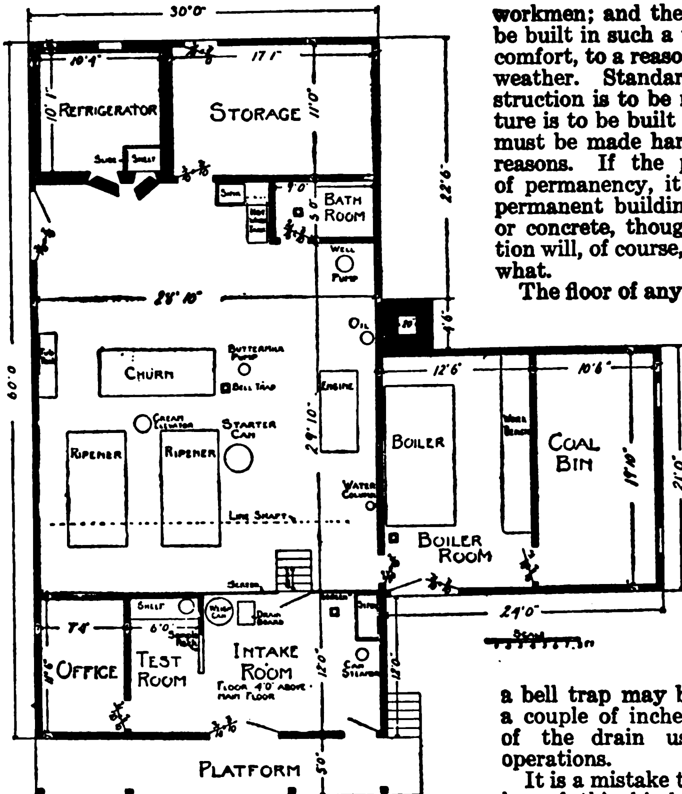



FIG. 610. Floor plan of a creamery such as a community of dairy farmers could coöperate to build, support, and profit by.

near the intake and should also be in close proximity to the office where the records are kept. The intake, testing room, and office may well occupy the south end of the building.

This leaves the main workroom to be located at the centre of the building, which is its logical location, in order that it may fit in with the most efficient scheme of sequence in operations.

Provision must also be ma'e for a boiler room; and there must not only be room for the boiler itself, but there must be some storage room for fuel. It is always a good idea to have a small repair shop, for quite often the creamery is a more or less isolated building, and to get repairs done quickly may prove rather difficult unless they can be done at the plant. Some sort of a wash-room should also be provided for the workers in the plant, as well as locker accommodations for their clothes.

Construction. A dairy building of this kind calls for a good type of construction. It operates the year 'round with a force of workmen; and the structure must, therefore, be built in such a way as to provide for their comfort, to a reasonable degree, in all kinds of weather. Standard double-wall building construction is to be recommended if the structure is to be built of wood. The inside walls must be made hard and smooth for sanitary reasons. If the project shows any degree of permanency, it may be well to use more permanent building materials, such as brick or concrete, though the expense of construction will, of course, be thereby increased somewhat.

The floor of any dairy building should be of concrete. If heavy machinery is to be placed upon it, it should be constructed very carefully, with a proper subbase covered with not less than 6 inches of a good, rich mixture of concrete. The corners of the floor should be rounded, in order that no recess may be formed for the accumulation of dirt. A slope of, perhaps, 1 inch in 8 or 10 feet should be made toward some point at which a good drain provided with a bell trap may be located. A depression of a couple of inches in the immediate vicinity of the drain usually facilitates cleaning operations.

It is a mistake to make the walls of a building of this kind low. Ventilation is absolutely essential, because great quantities of steam are usually produced and must be carried off. In the summer time, the air is likely to become oppressive if the walls are low. A height of at least 14 to 16 feet is to be recommended, and as many windows as possible should be put in. Since it is ordinarily necessary to attach line shafts to the wall and ceilings for the operation of the various machines, care must be taken that adequate strength is provided to support rather heavy loads.

In the wintertime, some form of heat must be provided. This may be furnished by the exhaust steam from the boilers; if this is not sufficient, the boiler should be designed large enough to furnish an additional supply of live steam for heating purposes.

The equipment for houses of this kind will depend upon the size of the plant; but the various items will be practically the same for either a large or a small plant, varying only as to size. The equipment for a creamery in a community where the milk from, perhaps, 1,000 cows is handled, is given in the accompanying list which has been taken from Bulletin 224 of the Wisconsin Agricultural Experiment Station.

SUGGESTED CREAMERY EQUIPMENT

| | | | |
|---|---|---|---|
| 10-horsepower steam engine | can steamer | water heater | moisture-test scale |
| 15-horsepower boiler | butter printer | cream elevator pump | moisture-test apparatus |
| small truck | starter can | cream-testing scale and equipment | salt-test apparatus |
| platform scale | print scale | water bath | acidity-test apparatus |
| weigher for buttermilk and skimmilk | tub paraffiner | 24-bottle turbine tester | office equipment |
| churn | tub tank | conductor head and spouts | cleaning utensils |
| two ripeners | water tank | 60-gal. weigh can | shafting and pulleys |
| | buttermilk tank | | repair equipment |

# SOME CHEESE FACTORY DETAILS

*By* PROFESSOR J. L. SAMMIS (*see Volume I, Chapter 44.*) *Although the cheese factory, like the creamery, is not a farm structure, it is one about which the farmer, especially the dairy farmer, should have some knowledge. In many cases he may have a coöperative interest in its management; in others he may depend upon its success for a large percentage of his returns. In any case he should be interested in its efficiency and sanitation and know how they can be maintained and improved.*—EDITOR.

It is a little more than 60 years since the first cheese factory in America was established, in Herkimer County, New York. The early factories were constructed in nearly every case of wood, and were somewhat makeshift in character; but the rapid development of the factory system was accompanied by a corresponding improvement in the buildings in which the industry was carried on. To-day, the thousands of cheese factories in the United States include a large number of buildings which are of a substantial character and are constructed on sound sanitary principles.

The most careful attention should be given to the internal arrangements of the cheese factory, so as to insure perfect cleanliness, without which, indeed, no cheese factory has a justifiable right to exist.

**Location and dimensions.** The use of a lot, large enough for the factory and affording also a vegetable garden for the maker, may often be secured free of charge from a farm owner who wishes the factory located near by. The building should be planned large enough to admit of using an additional vat or two, when the natural increase in the milk supply makes this necessary. The curing room at an American cheese factory may be built one half to two thirds as large as the makeroom, since cheese are commonly shipped every week, as soon as the surface is well dried. The rooms above the factory may be used partly for the storage of cheese boxes and partly as living rooms for the maker's family, the latter being a great convenience for the maker in going to and from meals, etc.

The intake, whey tank, coal bin, and cheese-shipping door should be located conveniently with reference to the driveway.

**Curing room, whey tank, and boiler room.** The curing room should be located on the north side of the makeroom, as this affords the best protection to the cheese against temperature changes. The intake, if located on the east side, will be then best lighted in the early morning and protected from north and west winds in winter. The whey tank should be located within sight of the intake, but far enough along the driveway to afford room for several teams to stand. The boiler room should be close to the intake or within easy access from it, so that the maker can conveniently get up steam and take in milk during the early morning.

**The makeroom.** The dimensions of the makeroom should be arranged to fit the vats and other machinery. In most cases, and especially where more than 2 vats are used, it is best to place each vat with one end toward the intake, so that a single long conductor pipe may be used for all vats.

A cement floor, extending for a foot or more up the wall and provided with sufficient pitch and with bell drain traps, is far better than a wooden floor. The walls and ceiling of the makeroom should be finished and smooth, so as to be kept clean without difficulty. High ceilings, plenty of light, and screened windows and doors are necessary. All pipes or utensils used for holding milk or other food for man should be built and located so that all parts can be readily seen and cleaned daily. In Wisconsin, where factories and makers, after passing satisfactory inspection, are licensed by the Dairy and Food Commissioner, the sanitary requirements as to the construction and operation of a factory are described in printed rules and suggestions.

**The whey tank and its care.** A stinking whey tank which can be smelled by passersby is both intolerable and unnecessary. The whey tank should be emptied and scrubbed

regularly; and an accumulation of spilled whey on the ground below the outlet should be prevented, as this may be the principal source of bad odor. To this end, a cement block, perhaps 8 feet square, with a good pitch toward the middle, should be located below the whey-tank outlet. A drain tile, with an iron grating opening at the lowest point in the centre, will allow all spilled whey to be quickly scrubbed down and carried away in the drain, thus avoiding a foul-smelling mudhole at this point. With a properly built septic tank, many factories in Canada and elsewhere dispose of their scrub water, etc., without creating a nuisance.

The accompanying suggested equipment for a cheese factory, also abstracted from Bulletin 224 of the Wisconsin Agricultural Experiment Station, may prove helpful.

SUGGESTED CHEESE-FACTORY EQUIPMENT

| | |
|---|---|
| 10–20-horsepower boiler | curd forks |
| 4–8-horsepower engine | curd pails |
| force pump and jack | curd strainers |
| 600-pound platform scales | dippers |
| 60-gal. weigh can | strainer dippers |
| conductor head and spout | curd mill |
| strainer rack | cheese knife |
| Babcock tester | cheese trier |
| 2 sample jars for each patron | churn |
| | cream ripener |
| acidmeter | butter printer |
| Wisconsin curd test | cream-testing scale |
| Marschall rennet test | whey separator |
| sampling dipper | counter scale |
| hoisting crane | paraffin tank |
| 600-pound cheese vat | wash sink |
| curd agitators | starter can (40-gal.) |
| double presses for cheese | tin pails |
| 50 cheese hoops | galvanized iron pails |
| horizontal curd knife | cleaning equipment |
| vertical curd knife | office equipment |
| hand rakes | shafting and pulleys |

repair equipment

FIG. 611 Harvesting the ice crop. Every farm that can do so, should make this one of its regular operations

# CHAPTER 37

# Icehouses and Cold-Storage Houses

*By* PROFESSOR R. P. CLARKSON (*see Chapter 14*). *Aside from the advantages it offers as a means for keeping foods of all kinds in good condition in hot weather, there are two reasons why every farmer that can should cut and save his own supply of ice. In the first place it can be done at no cost whatever save that of his labor and hauling expense; secondly, the work can be done only during winter when no other jobs demand immediate attention. Moreover there is always a market for any surplus, either in the nearest village or among his neighbors. The use of canned goods and the tendency to buy meats of the butcher rather than to raise, kill, and dress them, have to some extent dimmed the importance of cold storage facilities. But to balance this, the increasing popularity and use of concrete and hollow tile offer the inducement that an efficient icehouse can be more easily and more cheaply built and a supply of ice more easily gathered and more economically kept than ever before. Practically the whole story of how to do it is told in the next nine pages. Every farmer within reach of a pond and freezing weather should learn it, act upon it, and profit by it.*—EDITOR.

FOR more than 100 years traffic in ice has been carried on until it has so outgrown natural supplies that artificial-ice plants have sprung up all over the country and artificial ice can be sold in most sections cheaper than natural ice. Since about 1830, when the export trade reached its height, practically all tropical supplies have been produced artificially on the spot, whereas before that time thousands of tons of ice were shipped around the world. Notwithstanding this situation, the individual farm icehouse, storing up the natural ice from some small nearby pond, is a very desirable thing for every economical farmer. The lack of a natural pond or of a freezing climate does not, by any means, shut him off from the advantages of cold storage. Artificial-ice plants, refrigerating methods without ice, and other methods of preservation, are all open to him at comparatively small cost.

**Icehouses for the farm.** The advantage and convenience of having a good supply of ice is far beyond the small cost of gathering it, not only to the general farmer, but also to the dairyman, the country merchant, and the rural dweller. Often a vacant shed, a corner of the barn, an unused cellar, an empty silo, a vegetable storehouse, a dry well, or even an old cistern in the ground, when properly cleansed and fitted up in accordance with the principles here given, will serve as a satisfactory icehouse for many years. The successful icehouse is not necessarily the most expensive one. In southern Virginia a hole dug in the ground entirely above the water level and lined with native clay held ice satisfactorily


FIG. 612. Concrete blocks, being provided with interior dead-air spaces, make an excellent icehouse.

through the fall. Its only covering was of leaves and pine boughs. This was the type used by the Romans in the early ages to preserve snow, and it is now quite common in many parts of this country.

As another extreme of simple construction, a farmer in New York state built four walls of a single thickness of board supported by upright green poles freshly cut from the woods. He filled it with ice surrounded by a foot of sawdust, using a layer of sawdust for a floor and another layer for covering. It had no roof, doors, nor windows, and the ice kept all summer without much waste. This type is now being suggested to the natural-ice dealers.

**Secret of keeping ice.** It is obvious from these two examples that building material, whether wood, earth, stone, brick, or concrete, may not be the deciding factor in the keeping of ice. The secret is in the strict observance of four principles all of which finally reduce to one, namely, good insulation. First, there must be good under-drainage to carry off the melted ice, otherwise it would form a conductor of heat to the remainder of the ice stored, and would gradually melt it from underneath. Water melts ice much faster than air, for the latter merely affects the surface while the former penetrates throughout. Second, there must be perfect ventilation at the top of the ice in order that the covering of sawdust, straw, hay, moss, or leaves may be kept as dry as possible so that it will not form a conductor for the heat from the air and melt the ice on top. Third, the ice must be packed so as to prevent the circulation of air through the mass, for there is certain to be some heated air enter into the house when the doors, windows, ventilators, or top are opened. These currents of air rapidly warm up, while dead air does not readily become heated because of the fact that air is a very poor conductor of heat. Fourth, good insulation at the sides and bottom must be carefully provided.

**Size and capacity of house.** The size of the house needed may be determined from the fact that a ton of stored ice occupies approximately 42 cubic feet of space. The average size of house for a small farm is about 10 feet high from the ground to eaves, with an inside area 12 by 14 feet. After allowing for the space occupied by the sawdust around and under the ice, this will give room for the storage of from 25 to 28 tons of ice. A cubic foot of solid ice weighs close to $57\frac{1}{4}$ pounds, so that 35 cubic feet would weigh a ton. From this we can estimate the amount possible to cut from a pond. The thickness of the cakes usually cut ranges from 6 inches in the central states to 16 and even 20 inches in the north; probably 12 to 14 inches is the average. The cakes are cut in various sizes, also; perhaps 12 by 16 and 16 by 16 are common sizes, but this is not important. Assuming cakes 12 inches thick and 12 by 16 inches, there will be 26 of them to the ton, each one weighing $76\frac{1}{3}$ pounds. In the field, allowing for breakage and waste, a surface of 50 square feet will harvest at least 45, and possibly 50, tons of 12-inch ice.

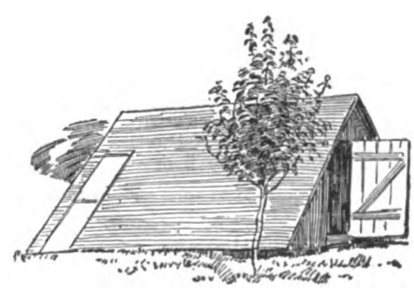


FIG. 613. By building the icehouse wholly or partly underground both its first cost and the loss of ice by melting are lessened.

## The Ice Crop

**Care of the ice field.** The essential thing is to provide for clear, clean ice of sufficient thickness. Before the water freezes it must be purified as far as possible. Sources of possible pollution must be removed, all rubbish taken away from the field and branches or floating logs cleared out. These factors carefully looked after will insure clean ice. Motion of the water during freezing not only expels the air but also promotes the growth in thickness. By expelling the air the ice is made clear, and sometimes it is desirable to induce a gentle current all through the field during ice-making weather for this purpose as well as for the additional thickness gained. The method of doing this in the case of landlocked ponds is to provide an outlet which must be readily controlled, as too rapid or violent motion will retard the growth of ice.

FIG. 614. Removing snow with a scraper before cutting ice.

After freezing has taken place the watchfulness of the farmer is properly directed toward increasing the thickness of the ice and keeping it clean. The handling of snow is important. Except in warm weather, snow should be removed as soon as possible, as it prevents the escape of heat from the water and thus retards growth of the ice. In soft weather, however, the snow is desirable to act as a blanket in shielding the water and ice from the heat of the sun. In case of rain, also, the heat of the rain is largely used in melting the snow and thus does not affect the ice so much.

**Clearing off snow.** After a thaw the snow and water on top of the ice freeze and form a porous cloudy layer. If not too thick and it is near the cutting time, this layer is not altogether a detriment. It detracts from the quality of the ice, to be sure, but it makes the handling of the ice easier. It prevents breakage of cakes in packing either for storage or in shipment.

For removal of snow when desired, there are two main methods. If the ice is strong enough, horse-drawn scrapers are used. If the ice is thin, at every 8 or 10 feet holes are cut in the ice through which water rises and floods off the snow by melting. Then, as the ice thickens, the snow ice which may be formed is planed off if necessary.

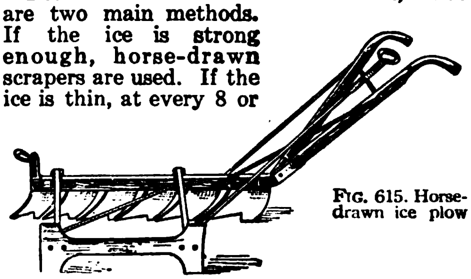


FIG. 615. Horse-drawn ice plow

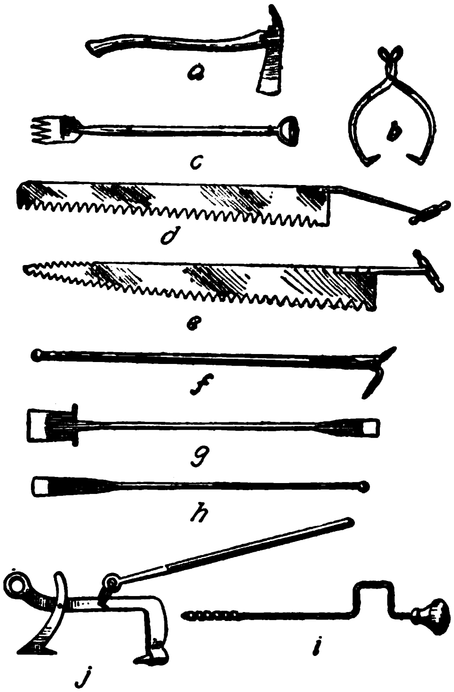



FIG. 616. Hand tools for ice harvesting: *a*, tapping axe; *b*, tongs; *c*, trimmer bar; *d*, saw; *e*, saw for "breaking out;" *f*, ice hook; *g*, bar for "breaking out"; *h*, splitting chisel; *i*, ice auger; *j*, grapple iron.

**Tapping the ice.** Continued soft weather or a thaw during the growth of the ice is one of the serious times with an ice field. If water washes on to the ice, it must be removed at once, and usually the only way possible is by tapping holes in a number of places so that the water will flow off and the ice, being lighter, will be raised. It is not worth while doing this if only an inch or two of water stands on top, as this may be allowed to freeze and may then be planed off.

**Harvesting the ice.** The first move is to inspect the field thoroughly and mark all shallow or dangerous places. The field is then laid out with a marker, which is really a hand plow made to cut a light groove along the line. The horse plow is set in the groove and run back and forth until the ice is cut more than half through. This is done with all lines in one direction and then with all lines in the other, the pond being thus cut into squares.

The next move is to open a channel by deeply plowing the groove on either side and sawing through completely with an ice saw. This channel section is then split into cakes which are usually pushed under the remaining ice in large ponds to open up the field quickly. In small ponds, however, they may be floated to shore and stored.

With an open channel to shore, sections of perhaps 100 squares are sawed off and floated, the sections being split into cakes just before being pulled out of the water. These floats, however, must not be left too long, as the grooves will flood and freeze up.

Tools required. A field planer, ice auger, tapping axe, snow scraper, marker, horse plow, ice saw, breaking bar, splitting chisel ice hooks, trimmer bar, ice adze, several grapples, loading tongs, and packing chisel constitute a reasonably full and quite inexpensive equipment for the proper handling of any considerable quantity of ice. For a very small field it is possible to do without most of these tools. Hoes and scoops or shovels may be substituted for the planer and scraper. A hand marker and an ice saw will cut the field up. A pair of tongs will lift each cake out and carry it to the drag or the incline leading to the house and an ordinary axe will trim the cakes. Use of the tools mentioned above save time and labor, especially the former, which is of real importance in harvesting during uncertain weather.

## Building the Ice House

**Material of building.** Having determined upon the size of house and the outlay of money that can be afforded, it remains to determine the material to be used and the plan to be followed. Beyond any reasonable doubt wood is better in many ways than stone, brick, or concrete for icehouse construction, although any of these may be used with satisfaction if the ice is packed far from the walls and well insulated from them by 10 or 12 inches of sawdust. The only objection to wood which any one can have is its tendency to rot under the continued influence of moisture inside and dryness outside. For this reason cypress is to be highly recommended as a serviceable wood, although pine will last for some years and is quite generally used.

**Underdrainage and foundation.** For a foundation concrete is best, all things considered. Let it go into the ground below the frost line and extend a foot above ground, to keep the sills dry. Unless the soil is well drained, there should be a main ditch with side branches cut in the floor, covering the whole space below the ice, the main ditch leading out on the lower side. Fill the ditches with broken stone, crockery, brick, or clinkers, and spread a thin layer over the whole floor. On top of the stone place a layer of straw covered with a thickness of coal ashes. On top of the ashes may be placed floor boards with cracks between them to allow free drainage of the water from the melted ice. More often, however, the boards are dispensed with and an 8- or 10-inch layer of sawdust put directly on the ashes, the ice being packed on that.

FIG. 617. The ice is cut about half way through into blocks. These are split apart, floated to shore and loaded upon sleds or stored in an icehouse if near by.

**Side walls and insulation.** The walls may be either single or double, and should be built with matched boards or papered with tarred roofing paper. I would recommend both. The paper is cheap, costing \$4.50 to \$5 for a 500-foot roll, so that it does not add much to the cost of the work, while it certainly gives a much better house. If the single walls are papered the papering should be on the outside, of course, while if the building is made with double walls the papering should be on the sides within the air space. Double walls are much better for insulation, and may easily be made by nailing the boards on both sides of the 2 by 4 joists used as uprights. This leaves a 4-inch dead air space between the walls, which should not be filled with sawdust nor with anything else. The best insulator is dead air, and the purpose of sawdust, felt, wool, shavings, and such substances is merely to keep the air dead—that is, these substances prevent circulation of air by catching small quantities in the spaces between the particles. The use of these substances is not to be recommended, either in icehouses between walls or in the walls of cold-storage boxes. In either case the filling would become damp and remain so, thus rotting the construction from the inside. In

cold-storage boxes it will also absorb and retain odors, making the box unfit for holding eatable produce. Furthermore, when damp, such fillings are reasonably good heat conductors.

**"Pocketing" the air.** In the air space between the boards, in the icehouse construction, every 3 or 4 feet up there should be a strip of tarred paper tacked, to form a horizontal partition, thus preventing any up and down circulation of the air. The result of this construction is that the ice is surrounded by walls consisting of a large number of boxes containing dead air. These boxes will be from 3 to 4 feet square and 4 inches thick—the thickness of the air space.

**House sills.** The sills of the house should be laid directly on the concrete foundation and in close union with the concrete, to prevent entrance of the air between them. In my experience it has been found desirable to lay a coating of tar or asphalt on the foundation walls and on this put the sills, thus making an air-tight job. There must be no entrance of air underneath the ice. It is true that a small amount will enter through the drain, if the latter is not trapped, but this is not sufficient to do any harm. In a commercial icehouse of large size, however, the drain should be of tile and trapped as it comes from under the icehouse. Preferably, too, there is a drain around the foundation on the outside, both of the drains being brought together and led away to a lower level.

**Roof and ventilation.** The roof for a small building may be of almost any material to shed the rain, keep off the sun, and provide good ventilation. The latter feature is the most important one in connection with building the house. The ventilators should be closable and kept closed on foggy days and nights. For this reason trap-doors on the sides and roof are preferable. The roof should be a V-shaped or hipped roof, with trap-doors at each end and at the ridge. Near the top of each end wall arrange a small door. Each fine, dry day open one of these doors and the opposite trap, so that the air may circulate freely and keep the top dressing or covering of sawdust dry. This top dressing should not be too thick, the practice being to have it from 8 to 12 inches. The dressing must be looked after and kept dry at any cost. It will be found helpful, although troublesome, to divide the top layer of sawdust by a thick layer of newspaper.

## Packing and Keeping the Ice

**Packing the ice.** In packing, the first layer is commonly placed on edge rather than laid flat. There is no less wasting that way, for, although each cake wastes less, there are more cakes on the floor. Sometimes this plan is followed throughout, the advantage being that in breaking the ice out there is less adhering surface between the cakes. It is harder to pack this way, however, and the liability to undue side-wall pressure is greater. At least every third layer, no matter how packed, should be laid so as to break the joints of the previous layer that there may be no circulation through the mass. The packing can be done up to within 6 inches of the side walls if a double wall is used, and up to within 8 or 10 inches with a single wooden side. As already stated, if concrete, stone, or brick be used, there should be from 10 to 12 inches left around the sides. In every case the space left should be filled with sawdust lightly tamped into place, but not rammed tightly. Hard tamping forces the sawdust down so solidly as to remove most of the air, while light tamping keeps the mass porous but yet held together tightly enough to retain the air and prevent its escape or circulation.

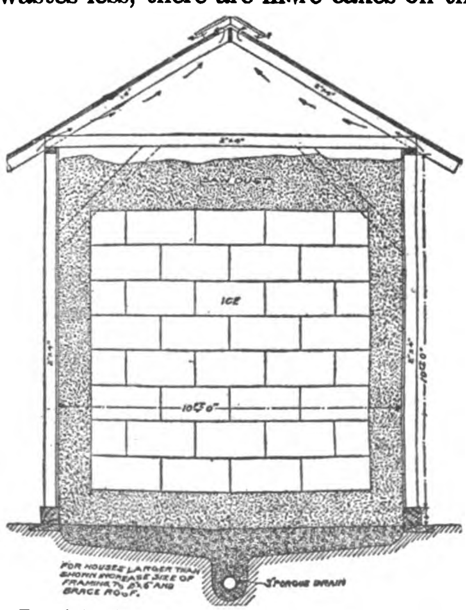



FIG. 618. Section through a small, wooden farm icehouse, showing sawdust insulation, drain for carrying off moisture, and ventilator openings for letting out the warm air.

Finally, it should be said that the cakes must be cut as true as possible, and no small pieces or broken cakes should be allowed to enter the house. The ice should be packed in freezing weather, so that the cakes will be dry and not freeze together in the house. Each cake should be kept an inch or an inch and a half from its neighbor on every side. Some ice dealers and others make a practice of filling this space between cakes with snow or broken ice so as to further prevent circulation of air through the ice. This has many advantages. It makes really a huge solid cake of ice in the icehouse but by reason of the weakness of the joints, it makes "breaking out" of cakes comparatively easy.

**Care of crop when stored.** Whenever the icehouse is entered, warm air is necessarily admitted as the doors are open. The ventilators should then be open as the warm air will cause vapor to collect above the ice, and this should be permitted to escape at once. The dressing on the top will need occasional attention, as it must be kept dry. Drains should be inspected, to see that they are not clogged.

**"Breaking out" the ice.** As the ice is removed, the top dressing should be kept in place. It is usually a good plan to take cakes from a number of layers at one time, the courses or layers being kept in a sort of a steplike series of tiers, the top tier being worked back the farthest, the next layer not so far, and the third still less. This allows greater ease of operation in every way. The cakes are usually pried out by a bent bar and separated from adjacent cakes of the same tier by a long-handled chisel, both tools being specially made for such purposes. Occasionally it is necessary to use a saw to separate the cakes at the sides. A special pointed saw is designed for this purpose.

## Cold-Storage Houses for the Farm

**Advantage of cold storage.** Most progressive farmers have learned the value of the individual icehouse on the farm, yet many have not realized that the most economical way of using the ice cannot be developed without a properly constructed cold-storage chamber. Creamery and coöperative cold-storage chambers are now quite common, and their importance is realized. As the farmer observes them in use for commercial purposes he will undoubtedly come to appreciate the value to him of a similar house at home built on a smaller scale. The great advantage of cold storage lies in the fact that produce need not be shipped to market immediately, but can wait a favorable time and a favorable market. Especially is this true of fruit crops, where the market is apt to be glutted during the usual delivery season, and a hold-back for a few weeks will help to equalize the supply. What is true of market shipments is equally true of meat and produce for home consumption. Purchases may be made at a favorable time and in considerable quantity. The produce raised on the farm for home use can be held over a longer period and waste more nearly eliminated.

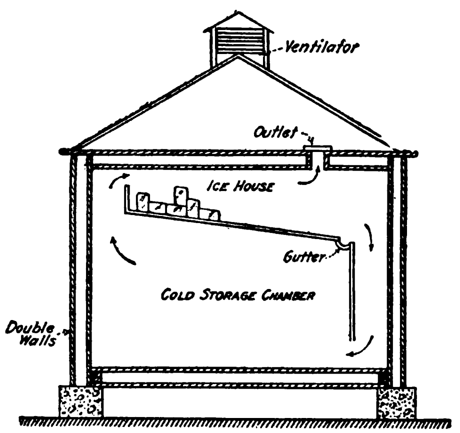



FIG. 619. Section of a combination ice- and cold-storage house for the farm. The slope of the floor of the ice chamber is exaggerated here; it should be merely enough to carry the water into the gutter. Note the double walls, floor and ceiling and the provisions for ventilation and the escape of warm air.

**Insulation.** The details of construction may, as in the case of the icehouse, be widely varied to suit particular needs. There

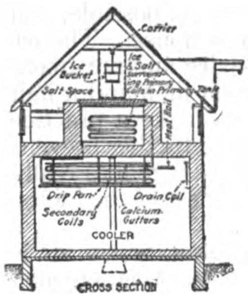



FIG. 620. Cross-section through a small cold-storage house.

are certain fundamental principles which can be laid down for guidance, however, close adherence to which will mean success in construction. Satisfactory insulation can be obtained through the use of double walls for the cold-storage chamber, in this way providing a dead air space between the walls, as that is the best form of protection. As the air within the space must be *dead* air, the walls *must* be air-tight to give satisfaction. There are many other ways of insulating, as by filling the space between walls with some so-called "non-conducting" substances, such as the following, which are named in the order of their desirability: hair felt, slag wool, wood ashes, chopped straw, charcoal, cork, and others. The insulating properties of these substances are largely owing to the fact that they enclose in the tiny spaces between their individual particles small amounts of dead air which cannot escape. That air is the insulator. For this reason the substances cannot be packed solid, and they should be tamped lightly into place rather than rammed hard. For cold-storage work it should be borne in mind that there is more to be considered than merely keeping the products. They must be kept properly and untainted. Something must be chosen for insulation which does not readily absorb moisture and odors. There is no one substance which does not do this to some extent. If the building can be built with matched boards and the dead-air space lined with tarred paper, the space need not be filled with anything. In fact, a filling would be a decided detriment. Absolutely dead air is essential, however.

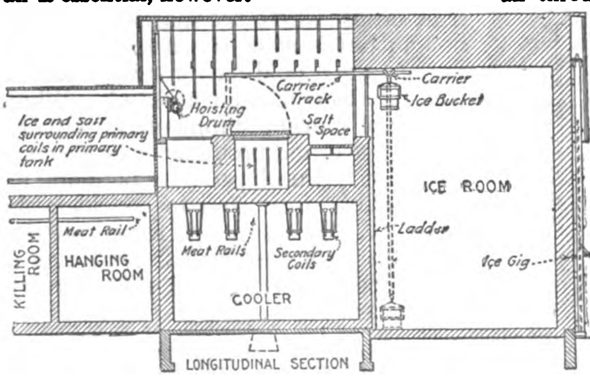



FIG. 621. Lengthwise section through the same house which is cooled by brine and constructed as part of a small slaughter house.

**Detrimental effects of dampness.** Moisture has the property of absorbing many gases and impurities from the stores, so that it is very desirable that the air in the food chamber be kept as dry as possible and that the moisture which it does take up be removed. In this way the air may be purified. The way in which this is accomplished is by providing proper circulation of the air in the storage chamber, thus cooling the stores by circulation of the cold air in contact with them rather than by radiation. Unless cooling is done in this way, the moisture which the air contains will be deposited on the stores and not on the ice. This, of course, will cause some of the packed material to become tainted.

**Circulation of air.** To secure a good circulation in the storage chamber it is only

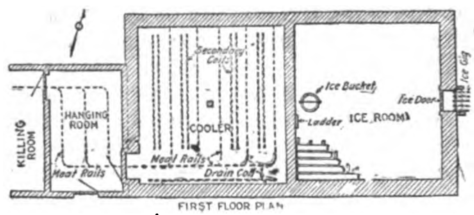



FIG. 622. First floor plan of the cold storage building shown in the two preceding figures

necessary to appreciate the fact that cold air falls and warm air rises. All that needs to be looked out for is to have the icebox above the level of the storage-space floors and to introduce the cold air at the bottom of the storage space and provide an outlet and return at the top of the chamber, to allow the heated air to go back to be cooled and deprived of its moisture. For a small chamber it will be satisfactory if the cold air is allowed to enter all along the lower edge and the warm air taken out at the upper and diagonally opposite edge. This will make it necessary for the air to cross and circulate all through the storage space before reaching the outlet. In a larger chamber, the cold air could be introduced at the centre of the floor and taken out at each of the upper side edges. In a still larger room, the cold air may be introduced along two side edges at the bottom and allowed to pass out through two side edges at the top. Shields or deflectors, which may be made of wood painted with enamel, should be placed so as to prevent the cold air, as it warms up, going from the inlet directly to the outlet without circulating through the room. These deflectors should slope from the bottom upward and be placed just over the cold-air inlets, so that as the cold air warms it will

rise along the deflectors toward the outlet. Care must be taken not to place the deflectors so as to pocket any warm air—that is, they should not be made so that any body of warm air will be caught in an upper corner and have to go downward to escape. Deflectors are necessary only where the outlet is nearly over the inlet and a path from one to the other does not lead through or near the centre of the storage space.

**Ventilation.** Ventilation is essential, but, except in very large rooms, it is satisfactorily taken care of by the opening and closing of the entrance door.

**Types of cold-storage houses.** The usual cold-storage house is a 2-story affair with the icebox on the second floor and the storage chamber below. Flues are provided to admit the descending cold air at the bottom of the storage chamber, and to take out the warm ascending air from the top. The water from the melting ice is carried away in drains which must be carefully trapped and sealed as in the case of the icehouse.

The cold-storage house can be built like the icehouse, described above, as to foundations, walls, and roof. A solid foundation is essential with strong floor beams and posts. The walls and floor should be double with an air space to provide insulation. The top ceiling should also be double. There should be a ventilator in the roof and a controlled opening through the ceiling of the icebox.

**Temperature maintained.** Usually the temperature best adapted for storage purposes is one of from 4 to 10 degrees above freezing. The lower temperatures, 34 to 36 degrees, are generally used, but some fruits do better at a little higher temperature. For freezing meats and poultry, temperatures much below 32 degrees must, of course, be maintained. This is done by means of a salt refrigerating tank.

**Refrigerating tank.** In place of the icebox, a water-tight sheet-metal tank is used. The tank must be fairly large, in order to have a large radiating surface. There should be about 4 square feet of radiating surface to 25 cubic feet of cold storage space. A drain is arranged for the tank, the bottom being sloped toward the drain, to allow the water to run off. As moisture will condense on the surface of the tank, provision must be made to drain the floor below. Usually a tray or pan is placed below. The tank is usually placed right in the cold-storage room, raised well above the floor. It is regularly supplied with ice and salt and, properly cared for, will maintain a zero temperature.

**Artificial refrigeration.** There are numerous machines on the market for maintaining a low temperature without the use of ice. The method used is scientific. Ammonia, which is naturally a gas, is very highly compressed, its temperature lowered, and the ammonia liquefied. The liquid is allowed to escape through a tiny valve into expansion coils and, being relieved from pressure, it vaporizes again into a gas. This requires heat, just as when water is boiled. The heat is supplied to the ammonia from the surrounding objects and they become colder and colder as the process continues. This action is like that of any vaporizing liquid. If alcohol be dropped on the hand, the hand becomes cold as the alcohol vaporizes, because the alcohol abstracts the heat from the hand causing vaporization to take place. Now, in the case of the ammonia, if the expansion coils be placed in brine, the heat will be abstracted from the brine and pans of pure water placed in the brine will be frozen. If the coil be placed in a cold-storage chamber, the temperature of the chamber will be lowered and kept lowered as long as the process continues. The ammonia gas is withdrawn from the expansion coils, compressed, and released again and, with a slight leakage, is used over and over again.

The process described is not always followed out in every detail, but is typical of artificial methods.

**Storage without ice.** Root and fruit cellars are quite common in all parts of the country. A cave in the side of a hill is commonly used in New England for a potato cellar and, in southern Europe, similar caves in the mountain-sides have been used for the storage of oranges. The essentials of such cellars are dryness and proper ventilation. Dampness always promotes decay, and lack of ventilation will frequently result in sweating. The sweating of fruit and vegetables upon sudden removal from such a cellar or from cold storage, always takes place, and the moisture formed must be removed before packing the produce for sale. To prevent sweating, bring the

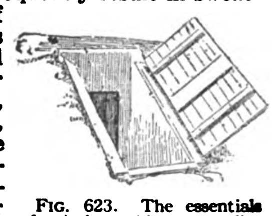


FIG. 623. The essentials of an iceless cold storage cellar are dryness and sufficient ventilation.

temperature of the produce gradually to the temperature of the outside air.

For indoor storage of root crops, a sand covering is very successful. A dry floor is essential. A layer of sand is spread and then the roots are spread in layers, each layer being covered with sand. The storage space must be kept ventilated. In place of sand, sawdust, hay, excelsior and sometimes lime is employed. The whole object is to keep air away from the fruits or vegetables so stored. Keep the air away, keep the produce dry, have good ventilation to prevent sweating, and a considerable degree of success is certain.

**Packing stores.** The packing of stores in cold storage is a science in itself and can be learned only by experience. One general rule, however, is of value and will take care of most difficulties, namely: pack the stores fairly close together and leave a space between them and the walls so as to allow a path for the circulating air. Never pack up close to the walls.

**Duration of cold storage.** It is difficult to give more than a general idea of the length of time for which any specific produce may be kept economically and profitably. This depends greatly on local conditions. Meats and fowl can be kept for 15 or 20 days and, when frozen, are, of course, frequently kept longer. Butter and eggs, cabbage, turnips, potatoes, etc., may be kept for months. Most fruits will keep a month; grapes, pears, watermelon and citrus will keep very much longer; and apples will keep six months.

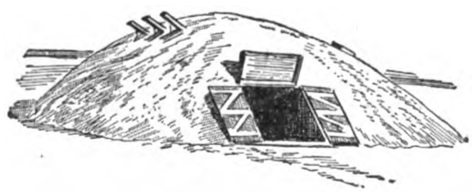


FIG. 624. Not a bomb-proof shelter, but an earth-covered potato cellar. Note the open ventilators; there is a similar set on the other side which can be opened when the wind is from the side opposite to them.

# CHAPTER 38

# Silos: How to Build and Use Them

*By* J. KELLY WRIGHT, *who for 8 years has been connected with the Missouri State Board of Agriculture in the capacity of Lecturer. During this time he has made a special study of silo types and uses, especially with reference to the needs of the average, practical farmer. He was born and reared on a Missouri farm, graduated from the State College of Agriculture, and served for 4 years as School Commissioner of Boone County. Among the many developments in agricultural education, which his farm training has enabled him to bring about, was the organization of the first boys' corn show held in his state.*—EDITOR.

THE silo is a container in which to store or "can" certain field crops in order that they may retain their feeding value and succulence (juiciness) and be relished by livestock. Feeders have long recognized the value of succulent feeds such as green grass. Feed stored and preserved in the silo is called ensilage, or "silage."

Silage is not a new feed, but in the United States it has been known less than 50 years. According to ancient writers, it was a common practice of the Greeks and Romans to preserve green feed and even grain in underground pits. This method has also been in use for hundreds of years in northern Europe where the uncertainty of the weather and the low temperature make it difficult to cure hay. However, it attracted little attention until in 1877, when a French farmer, Goffart, published a book giving the results of 25 years' experience in preserving green feed in this manner.

The first silo in the United States is said to have been built in Michigan, in 1875, by Manly Miles. Not long after this, agricultural experiment stations in America began to make feeding experiments with silage and to urge the building of silos. From this beginning the number of silos has increased until it is estimated that by 1917 there were 400,000 in the United States.

**How and why it pays to use a silo.** All classes of livestock feed better under summer conditions when feed is plentiful, succulent, and palatable, and surroundings are comfortable. By the use of a silo, summer conditions can more nearly be maintained during the winter months. Silage is the best cheap roughage. It can be fed with profit to all kinds of young, growing stock, to mature cattle of all classes, and, under certain conditions to other grown animals. When fed as a part ration, it is good for fattening lambs and for breeding ewes. It is also a good feed for colts and horses not doing heavy work, and has been fed successfully to fattening mules. As a tonic to keep hogs in good condition it may well be fed to them once or twice a

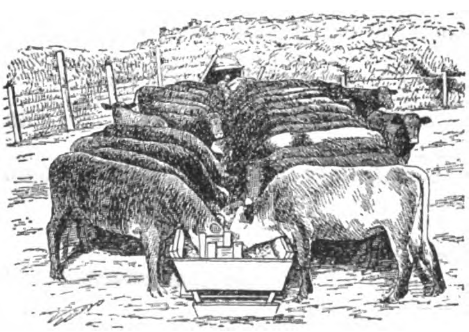


FIG. 625. The sketch at the top of this page shows a hard, wasteful, unprofitable way to feed roughage. How much better for both man and animals to feed silage —with or without grain—in bunks, in a sheltered yard, like this!

**A SILO WITH EVERY BARN**

1-WILL KEEP MORE STOCK
2-INSURES SUCCULENT FEED WINTER AND SUMMER
3-SAVES THE WHOLE CROP
4-PREVENTS WASTE IN FEEDING
5-HELPS UTILIZE OTHER FEEDS
6-SAVES STORAGE SPACE
7-IS FILLED AT SLACK SEASON

FIG. 626. What a silo does (International Harvester Co.)

week. In short, all stock like it and no better feed can be found on the general farm.

Silage is equally invaluable as a summer feed when, during periods of drought, pastures are short. Its use at such times often prevents a decrease in the flow of milk from the dairy cow, and a loss of weight in the beef animal. Experienced dairymen who know that when once a marked drop in milk production takes place, it is almost impossible, even with the best feeding, to bring a cow back to her previous high production, and feeders of beef cattle who have found it expensive and difficult to overcome a "slump" in weight caused by scarcity of feed, will appreciate what this means.

In the future the silo is sure to prove a yet more important factor in beef production. The great ranges of the West are being cut up as land advances in price; instead of the big, coarse, rough steer produced on cheap land and fed on cheap grain the ranges are supplying a smaller steer of better quality. These conditions, together with a great shortage of the world's meat supply, demand the most economical handling of feeder, stocker and breeding cattle. The silo will make possible such a system.

With a silo the number of head of stock that could otherwise be carried per acre can be doubled. More roughage can be stored in less space and fed out with less labor. Crops can be harvested and stored at a season when farm labor is not busy, and when the weather is good. The silage can often be fed indoors and exposure to weather be avoided; and even though it is fed in the open, the silo is a far better place to have kept the feed than a wet, muddy, snow-covered field could be. On many a farm the silo has lessened the feed and labor bill from 5 to 20 per cent and at the same time has made life more pleasant for the farmer, his boys and his hired men.

It is difficult to point out any single factor that alone can determine whether or not a man should have a silo. Hence it is difficult to say just how small a herd of dairy or beef cattle would justify one. Few good dairymen can afford to be without a silo. Every 160-acre farm near a market for dairy products could carry, among other classes of livestock, 10 or 12 good dairy cows and on every such farm a small silo would pay.

The general farmer with 20 or 25 head of cattle and horses to feed can certainly make good use of a silo; the general farmer who feeds a car-load or two of cattle each year will surely find a silo profitable over a series of years. Owners of some of the larger farms of the Corn Belt, and of some of the western ranges, find 25 or more silos none too many.

The larger a man's acreage in proportion to his business ability, the less use he can make of a silo. For the

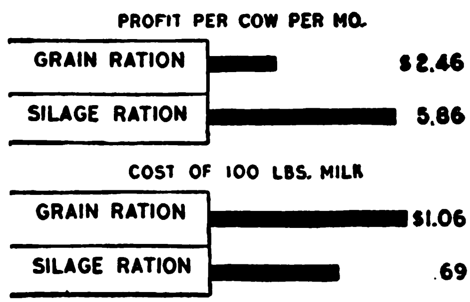



FIG. 627. The money value of a silage ration as compared with a straight grain ration (International Harvester Co.)

larger hir acreage the greater the amount of roughage at hand; and the greater the amount of roughage, the more of it a man can waste without seeing the need for a silo.

FIG. 628. Why do this of a winter morning when by filling a silo in summer you can feed better roughage, under cover, when snow flies?

## General Principles of Silo Construction

**Size and capacity.** The height of a silo should never be less than twice its diameter. The taller the silo is in proportion to its diameter, the more silage it will hold for the reason that a greater weight can be placed on any given area of surface, and more silage can be packed into it. To illustrate: the heights of two silos of equal diameters, one 12 feet high, the other 36 feet high, are as 1 to 3; but the amounts of silage that they will hold are about as 1 to 5.

The diameter of a silo should be determined by the number of head of stock to be fed, and the height by the number of days in the feeding period.

On warm summer days the silage on top, when exposed for more than a day, will begin to spoil; it therefore is necessary at such times to feed off from the top from 1 to 2 inches a day in order to keep the silage fresh and sweet. It will readily be seen that if the diameter of a silo is great and the number of head of stock to feed is small, the removal of enough silage each day to prevent spoiling might result in a waste of feed. It is much better to have two small silos than one very large one, especially when the number of stock is small and the feeding period long. Again, if two small silos are built in preference to one large one, one silo can be left undisturbed until needed, perhaps for summer use when pastures are short.

CAPACITIES OF SILOS OF VARYING SIZES IN TONS

| DEPTH OF SILAGE (FEET) | INSIDE DIAMETER IN FEET | | | | |
|---|---|---|---|---|---|
| | 10 | 12 | 14 | 16 | 18 |
| 25 | 36 | 52 | 68 | 96 | 122 |
| 28 | 40 | 61 | 81 | 108 | 137 |
| 30 | 44 | 68 | 90 | 115 | 150 |
| 32 | 50 | 72 | 95 | 126 | 162 |
| 34 | 53 | 77 | 108 | 142 | 171 |
| 36 | 57 | 82 | 114 | 158 | 194 |

The number of pounds of silage that an animal will eat in a day depends largely upon its size; for mature cattle it varies from 25 to 40 pounds. Since a mature beef animal will eat about the same amount of silage in a day as a dairy cow of the same size, the accompanying tables (from Bulletin 103 of the Missouri Experiment Station) are of value generally.

After knowing the capacities of silos of various sizes and the length of time the silage in each will last with a given number of animals to feed, the next question is the number of acres of corn required to fill a silo of given dimensions. The following figures show the average amounts of silage that an acre of corn will make:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Corn | making | 30 | bushels | per | acre | 6 | tons |
| " | " | 40 | " | " | " | 8 | " |
| " | " | 50 | " | " | " | 10 | " |
| " | " | 60 | " | " | " | 12 | " |
| " | " | 80 | " | " | " | 16 | " |
| " | " | 100 | " | " | " | 20 | " |

Thus a silo 14 x 30 feet will hold about 100 tons of silage which will feed 25 head of cattle about 180 days; to fill it will require about 10 acres of corn averaging 50 bushels to the acre.

**Shape.** Experience has shown that round silos or those nearly round are rather to be recommended than "square" or even 6-sided ones. Silage can settle and pack more closely around the wall of a round silo with the inside wall smooth and straight and such a silo can more easily be reinforced to resist the pressure of the silage. A few farmers, however, have filled square-cornered, strongly-built bins or granaries with green feed, particularly corn, and in some instances have produced a fair silage.

FIG. 629. No farm that supports a silo need ever be guilty of burning corn stalks as, unfortunately, some farms are.

RELATION OF SIZE OF SILO TO LENGTH OF FEEDING PERIOD AND SIZE OF HERD

| NUMBER OF COWS IN HERD | 180-DAY FEEDING PERIOD | | | 240-DAY FEEDING PERIOD | | |
|---|---|---|---|---|---|---|
| | ESTIMATED SILAGE CONSUMED (Tons) | SIZE OF SILO (Feet) | | ESTIMATED SILAGE CONSUMED (Tons) | SIZE OF SILO (Feet) | |
| | | DIAMETER | HEIGHT | | DIAMETER | HEIGHT |
| 10 | 36 | 10 | 25 | 48 | 10 | 31 |
| 12 | 43 | 10 | 28 | 57 | 10 | 35 |
| 15 | 54 | 11 | 29 | 72 | 11 | 36 |
| 20 | 72 | 12 | 32 | 96 | 12 | 39 |
| 25 | 90 | 13 | 33 | 120 | 13 | 40 |
| 30 | 108 | 14 | 34 | 144 | 15 | 37 |
| 35 | 126 | 15 | 34 | 168 | 16 | 38 |
| 40 | 144 | 16 | 35 | 192 | 17 | 39 |
| 45 | 162 | 16 | 37 | 216 | 18 | 39 |
| 50 | 180 | 17 | 37 | 240 | 19 | 39 |

**Construction details.** There are just two things that cause silage to spoil: (1) if the air gets to it, it will rot; and (2) if it becomes too dry it will mold. For these two reasons the wall of the silo must be tight enough to practically keep out the air and prevent the escape of moisture. In other words, the silo must be "almost air-tight." Control the two factors, air content and water content, and it makes little difference as to what the silo is made of, so far as its ability to keep silage is concerned. It is not enough, however, for the silo to keep air from and retain moisture in the silage. It must be strong enough to resist the pressure of the silage, not for one year, but for several; it must be solid and rigid enough to maintain its shape and efficiency for a long time; and it must have weight and durability enough to withstand the action of wind and weather, especially when empty.

## Kinds of Silos and Their Construction

Good silos have been built in a variety of ways and from many different materials. The first silos in the United States were made of stone or brick, with thick, substantial walls. These were expensive, and wooden silos were successfully tried. Silos can be grouped in two classes: (1) *temporary,* and (2) *permanent.* Whenever the cost of a temporary silo equals or approaches that of a permanent silo, the farmer should buy the permanent one.

### Wooden Silos

**The wooden-stave silo.** Probably the silo most commonly used is of the wooden-stave type. This is a good silo and will keep silage with as little loss from spoiling as any on the market; but not better than some others.

The stave silo, as it comes from the company, is ready to be put together. However, the purchaser must have prepared a foundation on which to set it. This foundation can be made of stone, brick, or preferably, concrete. The wall of the foundation should be from 8 to 12 inches in thickness and should extend from 2 to 3 feet into the ground, and from 1 to 1½ feet above it. A 32-foot continuous stave with a 4-foot foundation makes a good combination for a silo 36 feet in height. It is a good practice to make the foundation wall a foot thick at the bottom letting the outside slant in to 8 inches at the top, so that the inner wall is kept perpendicular. After the foundation wall is completed, a concrete floor should be laid. It should be concave, that is, several inches lower in the centre than around the wall.

A wooden chute should be built around the doors to prevent scattering of the silage when it is thrown down from the top.

Stave silos vary in cost according to the size and to the quality of the lumber. There are also differences in doors and in many minor parts. A continuous stave silo of good quality 16 x 32 feet, together with the foundation, will, under normal conditions, cost about $375.

The wooden stave silo demands more attention during summer when it is usually empty and apt to be neglected than at any other time. At this season when the weather is hot and dry, the staves shrink and the hoops get loose—sometimes so loose that the silo will

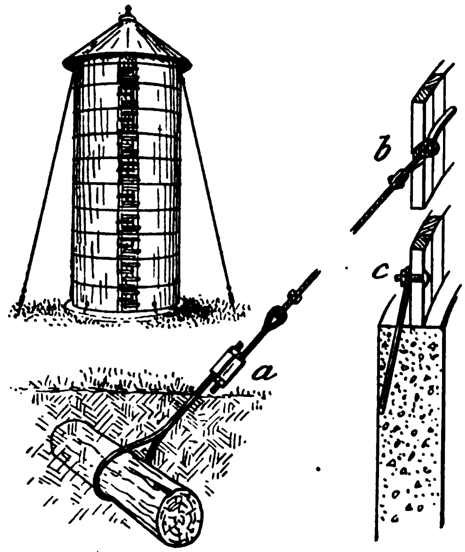



FIG. 630. Stave silo with guy wires; also details of *a*, turnbuckle and dead man; *b*, method of fastening wire to top of silo; *c*, additional brace support at base.

fall down—"fall to staves." When the hoops and staves of a silo become loose, a slight wind will sometimes blow it down, even if it be anchored. On the other hand, if the summer has been hot and dry and the hoops of the silo have been tightened several times, it will be necessary to loosen them when the silo is filled in the fall. If this is not done the moisture from the silage will swell the staves and may cause them to "buckle" in places, and sometimes let in the air or break the hoops.

Considerable difficulty is experienced with wooden stave silos in semi-arid sections where the weather is very dry and strong winds prevail. In other sections where material for building silos is scarce or not to be had unless it is bought, and where experience in building silos is limited, the wooden stave silo is a good silo to buy. When buying one, follow the instructions supplied by the maker or dealer regarding its erection and care.

Wooden-hoop silos. These are simply stave silos in which the hoops are of wood instead of metal. There are several varieties, but practically all are made of a good quality of pine flooring. The hoops are made four ply, of ½ x 4-inch white oak lumber, which will bend to conform to the circle required.

There are 2 methods of making the hoops. Perhaps the better and most common method makes use of a floor space or platform on which can be marked out a circle with a diameter 2 inches larger than the diameter of the proposed silo. After this has been done, wooden blocks 2 x 4 x 10 inches are nailed to the floor or platform 2 feet apart around the circle, inside and just flush with the line. Opposite each of these blocks and 4½ inches from it another block 2 x 4 x 8 inches is spiked down with the spike through the middle of the block. One corner of each of the outside blocks is sawed off at an angle of 45 degrees, the beveled or sloping side toward the centre of the circle. These outside blocks turning on the spikes serve as clamps to hold the hoop material firmly against the ends of the inner circle of blocks. In other words, the 4 layers of hoop material are placed between the 2 circles of blocks and are held in place by the outside blocks until they can be nailed together into one hoop. In this manner the required number of hoops can be made. They can be distributed 30 inches apart from the top of the silo one third of the way down, but from this point to the foundation they should not be more than 24 inches apart.

The foundation for this type of silo is the same as for any other. Perhaps the ordinary concrete foundation is best.

When the foundation and hoops are made and everything is in readiness for raising the silo, all of the hoops are placed on the foundation. Inside them and against the foundation wall 5 scantlings or poles are set up, equal distances apart around the wall, and anchored by means of cross braces and guy wires to hold the silo in shape until it is completed.

Beginning with the top hoop, each hoop is then raised to its place and temporarily held by crosspieces until the staves can be nailed on. From the point where one side of the door is to be, the staves are nailed on just as flooring is laid. In the event that some staves are short and joints must be made, the joints should alternate. The staves should be nailed on until only a 2-foot space is left for the door. The doors are made of the stave material, or flooring fitted in crosswise of the continuous opening. An extra stave is nailed on the inside 2 inches

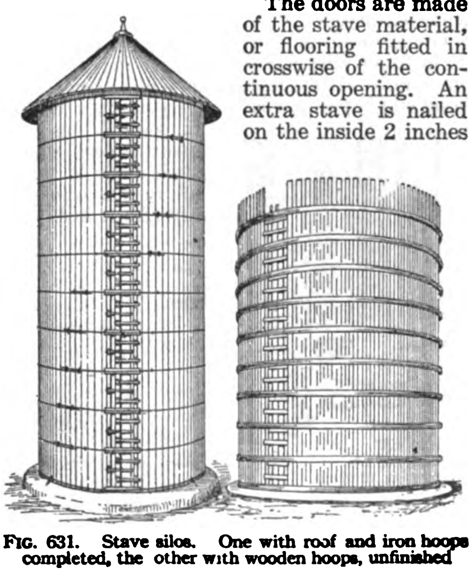


FIG. 631. Stave silos. One with roof and iron hoops completed, the other with wooden hoops, unfinished

back from the opening on each side to form the "door jambs." In addition, 2 staves are set in the opening one on each side, and fastened temporarily to the inner side of the hoops to form door cleats when the cross pieces are nailed to them. The cross pieces are fitted in from the bottom to the top of the opening and nailed to the staves mentioned. After the continuous opening is completely closed, the spaces between the hoops are numbered from the ground up. Then the cross-pieces are loosened from the top downward, and at each hoop the upright staves holding the doors are sawed through midway between the 2 hoops. This makes a separate door for the space between each pair of hoops, and each door will fit if kept in its place. The numbers previously placed upon them permit this to be done.

In sections where snow and sleet make feeding operations disagreeable, the silo should have a roof. Since the wooden-hoop silo is a homemade affair, any style of roof that the builder's ingenuity and taste may suggest, will suffice. The chute also can be made of any light material available.

The wooden-hoop silo can, under normal conditions, be built for about one dollar per ton capacity. However, there are modifications of the wooden-hoop silo which generally add to its convenience but also to its cost.

Instead of making wooden hoops, many farmers buy nuts and have the local blacksmith make and thread hoops of $\frac{1}{2}$ to $\frac{5}{8}$-inch iron rods to fit them. Such hoops can be adjusted from time to time. Many farmers have gone one step farther by making the walls of the silo in sections; a silo of this kind with iron hoops can be taken down or put up in a very short time and can be kept indoors when empty.

On account of the low cost, its efficiency in keeping silage, and the ease with which one handy with tools can make it, the wooden-hoop silo is popular in many sections. While it should be remembered that such a silo is, after all, only a temporary affair, it should also be remembered that it is worth what it costs and more, and that it is within the reach of farmers of moderate means. The use of such a silo will in most cases make possible the purchase of a more permanent one.

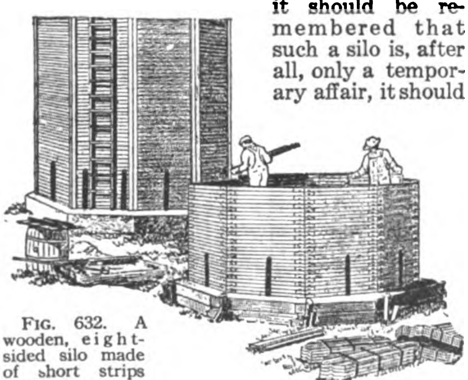


FIG. 632. A wooden, eight-sided silo made of short strips which are purchased ready milled, then laid horizontally and locked together. The corners are finally covered with protector strips.

Among other types of good wooden silos which, on account of lack of space cannot be described in detail, are the "Tung-Lok," a manufactured silo; the crib silo, a homemade, 8-sided affair made of 2 x 4-inch lumber laid flatways, each layer being nailed securely to the one beneath it; and the Buff Jersey, another homemade sort made of 2 x 4-inch lumber, not tongued and grooved but set up as staves and supported by iron hoops. The last mentioned silo has not given general satisfaction.

## Concrete Silos

**The solid or monolithic.** This is one of the permanent silos. When built properly, it will last more than a lifetime; it will not blow over; it needs no guy wires; it will neither dry out and fall down nor burn down.

If proper care is taken in making it, the solid concrete silo will keep silage perfectly; the statement that it "will not keep silage," is now seldom heard. It is true that some concrete silos have cracked, and that in some silage has spoiled. But if properly reinforced, the concrete will not crack. And if the correct proportion of cement, sand, gravel or chats and water is used to make the mixture airtight, this type of silo will preserve silage perfectly. One common mistake has been the use of too little cement; another has been the failure to get the right amount of water into the mixture. If the mixture is too dry, there will be porous places that will admit air; if too wet, the cement and sand will "run," leaving the aggregate without enough cement to prevent cracking and the entrance of air. However, any man who has had experience in making concrete walks, watering troughs, etc., can build a concrete silo; if he has had no experience at all in making things of concrete, his safest plan is to secure the services of some one who has. (See Chapter 25 on Concrete on the Farm).

Regardless of who builds the silo, he must remember: (1) to use enough cement; (2) to use enough reinforcing material. The mixture of cement, sand, and gravel (or crushed rock or chats) generally used is 1 of cement, 2 of sand, and 4 of gravel (a 1:2:4 mixture).

For reinforcing, woven wire has proven very successful, though half-inch iron rods distributed both up and down and around the silo are better. A woven wire fencing (38-inch, No. 9 wire, with a 5- or 6-inch mesh) answers the purpose very well.

The following estimate of cement, sand, gravel and woven wire is for a solid 6-inch concrete silo, 16 x 32 feet, made of the 1:2:4 mixture just mentioned.

| | |
|---|---|
| Portland cement . . | 220 sacks |
| Sand . . . . . | 15 cubic yards |
| Gravel . . . . . | 30 cubic yards |
| Woven wire (38-inch fencing, 40 rods) . | 2,090 square feet |

The following table shows the amounts of cement, sand, and gravel for silos of different sizes:

| MATERIALS | DIMENSIONS OF SILO IN FEET | | |
|---|---|---|---|
| | 12 x 28 | 14 x 30 | 16 x 32 |
| Cement, barrels . | 37 | 45 | 55 |
| Sand, cubic yards | 11 | 13 | 15 |
| Gravel or stone, cubic yards . . | 21 | 26 | 30 |

The forms for building concrete silos can be homemade or bought. If made at home they will cost about $50. The steel forms on the market are serviceable, easily handled, and can be rented out for enough to cover the first cost. A good plan is for several men in a community to share equally in making or buying the forms.

The cost of a solid 6-inch concrete silo, 16 x 32 feet, under normal conditions, will vary from $350 to $450, depending upon the price of labor and cement and the distance that the materials must be hauled.

The expense of maintaining the solid concrete silo is practically nothing. During the summer when the silo is empty its walls become very dry. For this reason they should be wet thoroughly before new silage is put in (this precaution should be taken with stave silos as well). Wetting the walls prevents absorption of moisture from the silage. Just as the inside of the stave silo should have a treatment of creosote once in 2 years, so the concrete silo should have a thin coat of cement and water of the consistency of whitewash, every 2 years. It will stop up all pores and keep the wall smooth.

**The concrete-block silo.** It is not claimed that the concrete-block silo will keep silage any better than the solid-wall type; however, the concrete-block silo has one advantage over the monolithic type, namely, the blocks can be made at times when other work on the farm is not pressing. These are of dimensions to suit the builder, and are hollow and made with a groove in one side through which passes an iron reinforcing rod. This type of silo must be well reinforced to prevent cracking. Many silos of this type are in use. Their average cost is about the same as for, a monolithic, or good stave silo.

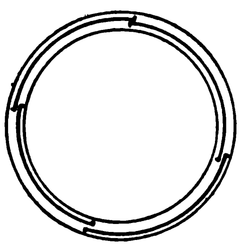


FIG. 633. How to place reinforcing rods in a solid concrete silo.

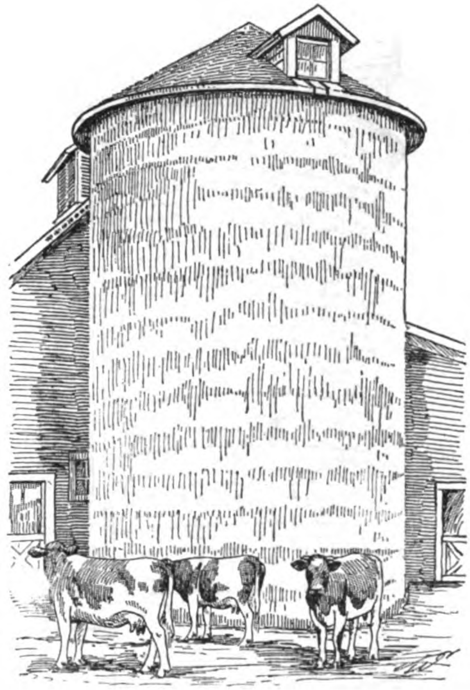


FIG. 634. The solid concrete silo, carefully made, is on of the strongest, handsomest, and most durable of all

## Hollow-Tile Silos

The hollow, glazed-tile silo is one of the best. On account of the material from which it is made and its resistance to fire and storms, it is classed as a permanent silo. Not only is it efficient, but also, in common language, it is a "good looking" silo in keeping with other first-class farm buildings.

This type should be considered by the man who wants a permanent silo and who has not on his farm or within easy reach the material for making a concrete silo. Especially should the hollow tile be considered by such a man if his experience in making things of concrete is limited, and if a professional concrete constructor is not available. Any good mason can build a hollow-tile silo.

The hollow-tile silo is made of hollow,

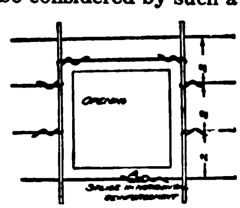


FIG. 635. Details of silo reinforcing around door

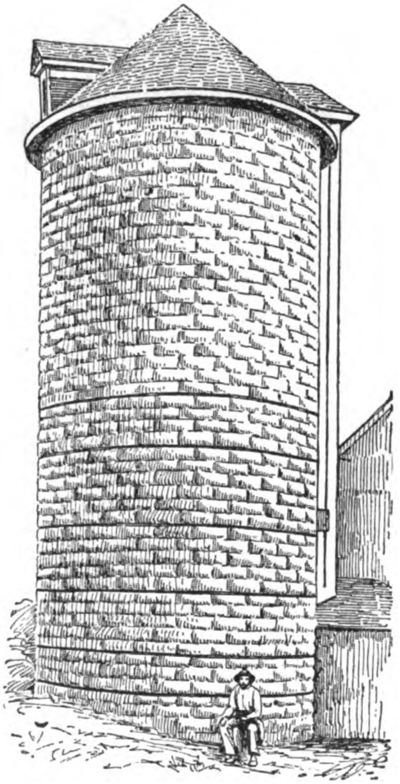


FIG. 636. The concrete-block silo is well suited to the needs and constructive ability of the average farmer. It must be well reinforced.

vitrified tile blocks reinforced usually by iron bands which fit into the mortar between the blocks or in grooves made in them. The curved blocks are laid on an ordinary concrete foundation such as would be made for any other type of silo, and when laid properly make a perfectly smooth wall. When the blocks are properly glazed, they are impervious to air and moisture. The hollow spaces in the blocks serve, it is claimed, as a protection against changes in temperature.

There are several makes of hollow-tile silos, both homemade and patented, among them the Iowa and the Dickey. Regardless of name, the best are those that are best glazed and best reinforced. Under normal conditions, the cost of a first-class glazed hollow-tile silo will be very little more than that of a first-class one-piece stave or monolithic concrete silo.

## Other Types of Silos

**The Gurler.** For the small farmer of limited means, and particularly for the man who is struggling to pay off a mortgage and cannot buy a high-priced, permanent silo, the Gurler is highly satisfactory. This silo gets its name from Mr. H. B. Gurler, of Illinois, the first to build one, but it is sometimes called the "plastered" silo. It is homemade and the cost is low, since native lumber can be used in its construction. A silo of this kind with a capacity of 100 tons can, under normal conditions, be built for $100 to $150.

The foundation is made of concrete extending from 1½ feet to 2 feet into the ground, and the same distance above. Before the foundation hardens, a sill is laid in the top of the concrete. To this sill 2 x 4-inch scantlings or studdings set 18 inches apart are nailed. To the inside of the studding, extending round and round, is nailed half-inch sheeting of native lumber; either elm, sycamore, cottonwood, or oak will do. Inside of this and running with the sheeting are nailed laths, also homemade if desired. If to be bought, steel laths are better. To the laths is applied a half or three-quarter-inch layer of cement plaster. There should be a cement floor, lower in the centre than around the wall. As soon as the plaster lining hardens, the silo can be used, but in order to protect the inner wall, boxing should be put on the studding outside, and painted. Vents or holes should be made in the boxing near the bottom and in the inner wall near the top to allow a free passage of air between the walls. This will prevent wood mold from forming and destroying the sheeting. A roof is not absolutely necessary, for enough water to injure the silage is not likely to fall into the silo, and snow does not injure the silage but merely makes it unpleasant to handle.

This type of silo, although temporary, when well built, will keep silage perfectly and will last 10 or 15 years, according to the material

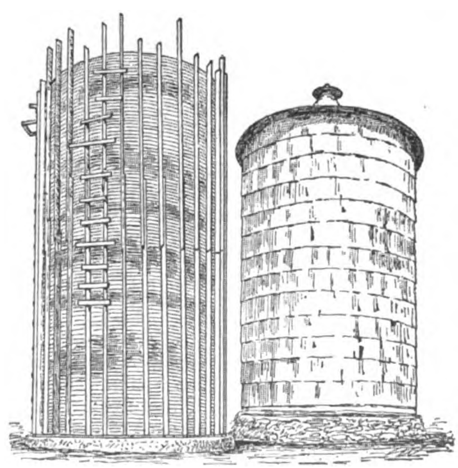


FIG. 637. The Gurler silo, though simple and low priced, is highly satisfactory. If sheathed with metal (*right*) and roofed over, its life is greatly lengthened.

used and the care given it. It will not dry out and collapse, and there are no hoops to keep tightened. Where all the material for the Gurler silo must be bought, a silo 16 x 32 feet can be built in normal times for about $225. If native lumber sawed from timber on the farm can be used, the expense will be less, perhaps not more than $125 to $150.

Another type of silo very similar to the Gurler is in common use. In it instead of the laths and cement plaster, a layer of tar paper is used, and inside this another thickness of half-inch sheeting. A silo of this kind is even cheaper than the Gurler. It will keep silage well and last from 10 to 12 years, perhaps longer, depending, of course, on the material used.

**The Minneapolis or panel silo.** The framework or reinforcing material of this patented silo is made of steel studs, which are set up perpendicularly and held in place by short wooden staves fitted in horizontally between them, and by iron hoops which hold the parts of the silo together. The staves are short and tongued and grooved. It is claimed by the manufacturers that this manner of using the stave permits little shrinkage of the wood and little difficulty in keeping the hoops tight. Whenever a stave appears defective, it can be cut out and replaced by driving all of the staves above it downward and inserting a new stave at the top.

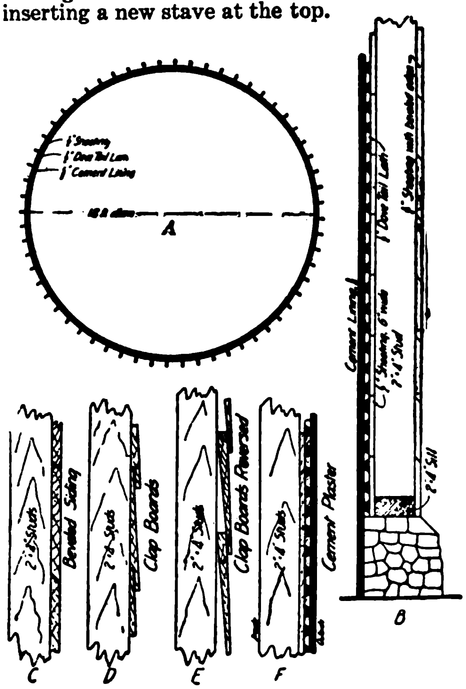



FIG. 638. Gurler silo construction showing: (A), plan; (B), section and details of inside finish; and (C,D,E,F) different methods of finishing the outside. (Wis. Bulletin 214.)

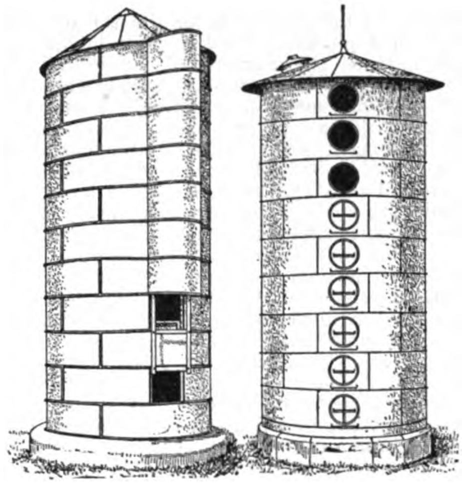


**FIG. 639. Metal silos illustrating two types of door construction, that on the left being continuous with an enclosing chute.**

**The steel silo.** There seems to be considerable demand for this type of silo especially in sections where dry seasons and strong winds seriously affect wooden silos. The steel silo in large sizes is more expensive than some other manufactured silos. However, it is a good silo, and if painted on the inside with asphaltum every year, it will keep silage perfectly. On account of the thin wall, silage will perhaps freeze in a steel silo a little more quickly than in some others.

**The plastered steel silo.** This is made of steel frames on which is fastened heavy woven wire. On the outside and inside of the woven wire, 2 inches of cement plaster are applied.

## The Pit Silo

This type, as the name implies, is built mainly below the surface of the ground. However, when a considerable portion extends above ground, it is referred to as a *semi-pit* silo; when such a silo is placed in a bank and the retaining walls serve as a chute, it is called a *bank* silo. Pit silos can be built and used successfully in sections where the water-table is well below the surface. It is not advisable to build a pit silo in water-bearing soils.

The pit silo has gained its popularity in semi-arid sections, although, under proper conditions, it can be successfully used in humid regions. It is becoming more popular in parts of the north and northwest, where the winter weather is very cold and where silage freezes considerably in other types of silos.

The manner of constructing the pit silo is simple. The top of the silo is built first; the ordinary foundation for any other type

of silo would serve well for the top or "collar" of a pit silo. First a circle having for its diameter the diameter of the desired silo is laid off, on the ground. Around the edge of this circle every 2 or 3 feet, are driven 2 rows of stakes 1½ feet apart, until about 1 foot of each stake remains above ground. Then half-inch sheeting, or any kind of board material that will bend, is bent around and nailed to the stakes, one strip being nailed on the outer side of the inner row of stakes and the other on the inner side of the outer row. The dirt is then dug from between the two rows of stakes to a depth of 2 or 3 feet and the trench filled to the top of the sheeting with concrete which is allowed to set. This makes a good concrete collar or a good foundation if the silo is to extend some distance above the ground. When the collar is made, the earth inside is dug out to a depth of 5 or 6 feet, and a coat of cement plaster from 1 to 1½ inches thick applied to the earthen wall. Then another 5 or 6 feet of earth are dug out, and another band of plaster is applied. In this way, 5 or 6 feet at a time, the pit silo is built. If the pit silo is to extend above ground, the extension can be of staves, concrete, concrete blocks, or hollow tile reinforced as in the ordinary overhead silo.

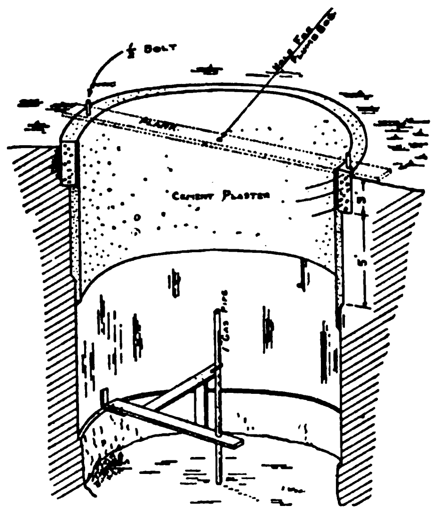



FIG. 640. Section of a pit silo showing collar, lining, and simple apparatus for keeping the size and shape accurate. (Neb. Bulletin 39.)

The most common method of removing the earth in digging pit silos is by means of an ordinary hay carrier track and tubs made from barrels. Horse power can be used for hoisting. If the hay carrier arrangement can not be had, an ordinary block and tackle or windlass can be used.

The greatest disadvantage of the pit silo is encountered in getting the silage out. However, this inconvenience is offset by the low cost of the silo and by the fact that it is long-lived, easy to fill, nearly air-tight, below the frost line, warm in winter, and cool in summer.

Of the various methods used for hoisting the silage out of the pit silo, the windlass is perhaps the most general.

At the time of filling the silo, and until the cells or tissues in the silage are dead, a poisonous gas (carbon dioxide) is formed. This gas is heavier than air, and for this reason is held in a pit silo unless it is open wide at the top so that currents of air from the outside can carry the gas out. A week or two after the silo is filled, the formation of gas is so slow that there is no danger from this source. The danger comes at the time of filling, especially if the silo is partly filled one day and the work finished a day or so later. At this time no one should get into the silo until a lighted candle or lantern has been lowered into it. If the light goes out there is danger. The danger is equally great in any overhead silo at or near filling time if the doors are in place for several feet above the level of the silage.

The cost of a pit silo 16 x 30 feet, full pit with roof and hoisting apparatus, is given in Nebraska Bulletin 39 (February, 1917) as $1.41 per ton capacity; the itemized cost is as follows:

| | |
|---|---|
| Labor | $ 62.85 |
| Board | 18.00 |
| 40 sacks cement | 20.00 |
| 8 loads sand | 4.00 |
| 100 feet half-inch wire cable | 2.50 |
| 150 feet three-quarter-inch rope | 4.00 |
| Rope | 4.00 |
| Carrier for cable | 4.00 |
| Rope and post to erect cable | 1.50 |
| One-half-inch by 12-inch bolts, top wall | 1.00 |
| Boxes to lift dirt | 5.00 |
| Lumber for roof | 20.00 |
| Total | $146.85 |

## The Care and Use of a Silo

**Care in building.** Great care should be taken that the walls be as nearly air-tight as possible and, if concrete, reinforced so they will not crack. The silo must be plumb, and its walls smooth and true. If it leans, the silage will settle away from the one wall and the air will get in. If the walls are left uneven and rough the silage will not settle properly.

FIG. 641. Hoisting rig for pit silo digging. The plank is swung to one side when the wheelbarrow is lowered.

**Care in filling.** In order to exclude the air, the silage must be packed carefully around the walls when the silo is filled. There is a tendency for the heavier pieces to fall in one place while the lighter ones fall a greater distance from the distributor. In order that the silage be uniform throughout the silo and settle uniformly, the weight must be kept uniformly distributed.

Each farmer should own his own blower and distributor. However, since it is more economical to use a large cutter than a small one, it is well for several neighbors to buy and use a large cutter jointly.

It is not advisable to buy a cutter with a knife less than 14 inches in length and a 17-inch knife is better. In order to keep all hands going and everything humming, the cutter should have a capacity of not less than 10 tons per hour, while 15 tons is better. It often happens that a cutter too small, choking down, getting out of order, and keeping expensive labor idle, is the cause of the high cost of filling a silo. The cutter should be set to cut the corn into half-inch lengths, and when so set should run right along without choking down. If it will hold up when set at this, it is not likely to fail when set to cut in longer pieces.

An engine, if not owned on the farm, might be hired or owned jointly. There is nearly always a traction engine in the neighborhood that can usually be hired at from $6 to $10 per day. A gasoline engine of not less than 8-horse power will do, unless the cutter is unusually large. It is always economy in the end to have an engine that can pull all that is required and a little more.

The number of wagons needed will depend upon the capacity of the cutter and the distance that the corn must be hauled. A driver will be needed for each wagon, and 2 men will be needed in the field to help load. If a corn binder is used, a man and teams to run it will be required in the field.

One man will be needed to run the engine, but he can help some at the cutter. Another man will be required all the time at the cutter. Two men should be in the silo and they should, above all things, be conscientious, active men, for on them depends the keeping of the silage.

If by waiting for the grain to mature, the stalk, blade, and shuck are allowed to begin to dry up, it may be necessary to add water to the silage as the silo is filled, or to run a small stream of water into the blower as the silage is elevated into the silo. There will be little or no danger of adding too much water; the danger will be, in all probability, in not getting enough.

When the silo is full, the top should be leveled off, tramped down firmly over the whole surface, and wet down thoroughly. The silage should be tramped down once every day for several days after filling.

If the silage has been tramped down properly around the walls of a good silo, there will be little or no spoiled silage around the wall. But the silage on top, if not protected by some sort of covering, will spoil down to a depth of from a few inches to perhaps a foot or more. To prevent this loss from spoiling, some men run a lot of wet straw through the cutter and blower, covering the silage to a depth of about a foot. Another practice is to sow oats on top of the silage, thick enough so that when they sprout they form a very thick mass of roots which provides a good tight cover. A few men have been known to "salt down" the silage when through filling. This, they claim, is a good way to prevent decay of the silage at the top. A barrel of salt is sufficient for a silo 16 feet in diameter. Other men have spread several inches of sawdust on top of the silage, and in this way kept the air out. Still another very good practice consists of running a half-inch layer

of pitch over the silage just as soon as the filling is completed. The pitch does not adhere to the wall of the silo enough to prevent its settling with the silage; it keeps the silage as well as any cover in use; and it is not expensive. When the silo is opened, the layer of pitch can easily be broken up, thrown into a barrel or box and used again.

If it is not convenient to follow any of the practices mentioned, a few loads of corn, from which the grain or ears have been removed, may be run into the silo at the last, and wetted down. This is a very common practice; if adopted, the loss will not be great even if the silage does spoil down to a depth of a foot. The cost of filling silos in the Corn Belt is from 75 cents to $1.00 per ton.

**Care in emptying.** When the silo is opened, all spoiled silage should be thrown off where stock cannot get it. The middle should be kept full, particularly in hot weather. If a "feather edge" of silage is allowed to remain around the wall in hot weather it will spoil and make unpalatable all the good silage with which it becomes mixed. The silage should be removed from the silo at a uniform depth each day, the exact depth depending on the number of animals and their appetites (unless on limited rations).

Every one knows that spoiled fruit, whether canned or not, is not fit for food, and should not be eaten. Yet in spite of this men have fed spoiled silage to livestock. Often nothing serious comes of it, yet frequently we hear of some man who fed spoiled or rotten silage and, as a result, lost some of his stock. The feeding of moldy silage is always a bad practice, as it may cause the death of the animals that get it. Freezing does not seriously hurt silage, but it should not be fed while frozen. However, because frozen silage is hard to get

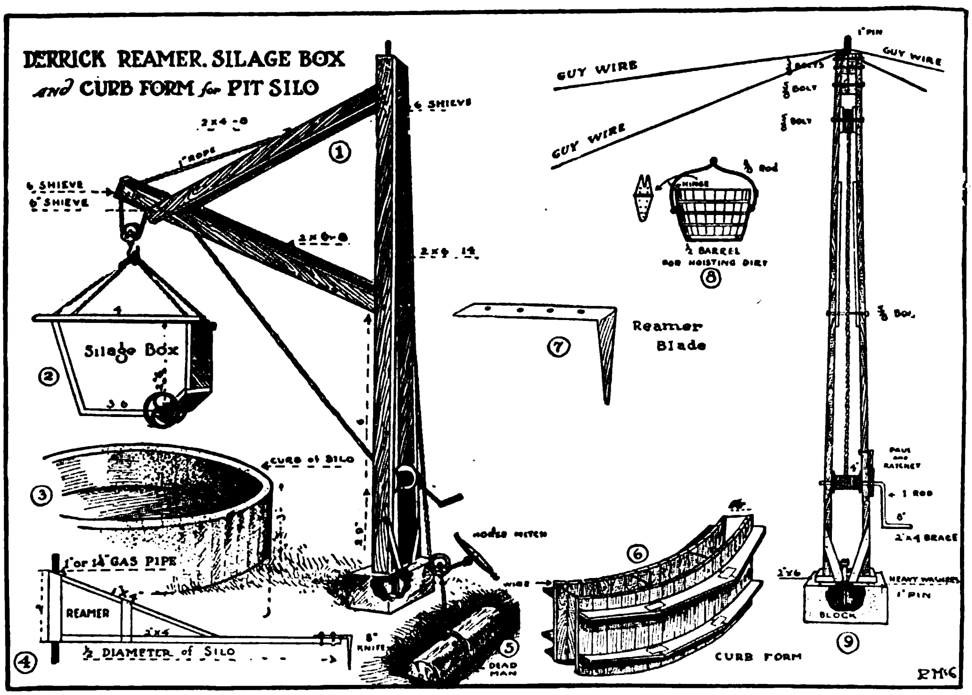



**Fig. 642.** Dimensions and arrangement of apparatus required in building and using a pit silo. (International Harvester Co.)

out of the silo and hard to handle, we never like to have it freeze at all if it can be prevented.

It should be remembered that one should never take stock away from good silage and put them on dry feed. In other words, a man should figure just how long his silage must last to carry his stock to grass again, and then feed with that date in mind. When fed silage, stock should have all they will clean up but not more. Thus in order to make it hold out until grass comes, silage feeding should not begin too early in the season. Of course, the man with both a winter and summer silo need not worry about this.

## Best Crops for the Silo

**Corn.** One of the greatest advantages of using a silo is perhaps the ability it affords of saving the corn crop. When land was cheap and there was an abundance of coarse roughage which had little economic value it was not so serious when a big per cent of the crop was wasted. However, when land and labor are high in price, it is imperative that we save all of the corn crop and follow a system of farming which requires less labor per unit of production. Considerably less labor is required in harvesting and feeding corn as silage than in any other way.

From 30 to 40 per cent of the feeding value of the corn plant is in the stalk, blade, and shuck. Practically all of this is lost when the corn is harvested from the stalk or from the shock. The expense of putting corn into the shock and shucking it out is double what the stover is worth. This loss of feed and money can be prevented by use of the silo.

The grain from an acre of corn yielding 40 bushels, when valued at 60 cents a bushel, is worth $24. On this basis, the stalk, blade, and shuck (representing 40 per cent, or two fifths of the feeding value) are worth $16. But ordinarily "stalk fields" sell for about $1.00 an acre. Here, then, is a loss of about $15 per acre, that can be prevented by the use of a silo.

It has been stated that "upon the basis of total food value 2½ tons of silage are equal in feeding value to one 1 of timothy hay." One acre of 50-bushel corn will make 10 tons of silage, the equivalent of 4 tons of timothy hay. On the basis referred to, with corn selling at $1.00 a bushel, a ton of silage is worth $6.70. Calculated in this way, an acre of corn yielding 50 bushels per acre when put into the silo is worth $67, while the grain at $1 a bushel is worth only $50. However, if 10 tons of silage is equivalent in feeding value to 4 tons of timothy hay and takes the place of the hay in the feed lot, then it is worth what the 4 tons of hay would sell for on the market. Silage takes the place of high-priced hay.

In some parts of the country, silo owners grow a special silage corn, which produces much foliage and little grain. Farmers in other localities, hearing about this corn, sometimes ask if a special corn must be grown for the silo. The answer is "no." The corn that grows best in a locality is the corn for the silo in that locality. Nothing is gained by filling the silo with corn that produces an inferior ear or none at all. The more grain the better and richer the silage, other things being equal. While an acre of so-called "silage corn" may yield heavily as silage, the feeding value of an acre of such corn would not necessarily be greater than that of ordinary field corn carrying more grain.

Some people when they see silage for the first time are surprised to find that the color is not as they had expected, green. This idea of having a green-colored feed, together with lack of experience, has resulted in the filling of many silos with green, immature corn, carrying a high per cent of water and a low per cent, comparatively, of nutrients. Experience has taught us that if we want the best quality of silage, we would better wait for the dent to form in the grain, even though the stalk and blades dry up a little.

There are a number of cases where silos were not completed at the time the corn was at the right stage for silage. The corn was cut and put into shock, where it completely dried out. Then it was run through the cutter into the silo with plenty of water, and made good feed. However, this practice is not the best. It is mentioned to bring out the point that cutting the corn too green is not advisable, and that, by the addition of plenty of water to the silage, corn can be allowed to mature before it is siloed, thus enabling us to secure the greatest amount of nutrients from an acre. Dry stover may require an equal weight of water to make good silage. As to the right stage at which corn should be cut for the silo, Prof. C. H. Eckles of the University of Minn-

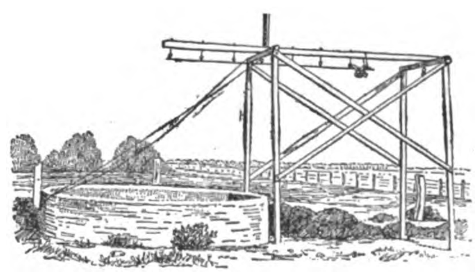


FIG. 643. Nebraska pit silo showing hay loader and track used for removing silage

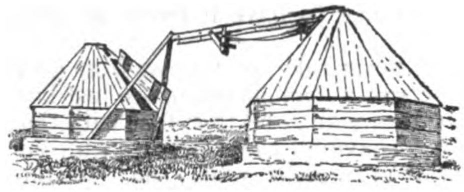


FIG. 644. Twin pit silos and a combined hoisting device for both. (This and Fig. 643, Neb. Bulletin 39)

esota (see Volume I, Chapter 41) says in Missouri Bulletin No. 103:

"The proper stage to cut corn is when it shows the first sign of ripening. In a year of normal rainfall, this is when the husks first begin to turn yellow at the end of the ear, while the leaves of the plant are still green. At this time the kernels are entirely past the milk stage and are glazed and dented. Silage made from such corn does not develop so much acid as when cut in a less mature stage, although it still develops a sufficient amount to preserve it."

**Sorghum.** After corn, sorghum ranks next as a crop for the silo. It yields heavily; sometimes, on good land, it will make from 12 to 15 tons of silage to the acre, although the yield is more often less than this. However, it yields about the same number of tons per acre as corn, soil, cultivation, season, and everything else being equal. There is considerably more water and more sugar in the sorghum plant than in the corn plant, and for this reason sorghum silage is apt to be sour.

Where sorghum is grown for the silo, it is a common practice, and a good one, to grow some corn to put into the silo with it. Best results with sorghum as silage have been obtained by making a half-and-half mixture in which a load of sorghum is run through the cutter, then a load of corn, etc. This practice is particularly advisable if the corn is a little dry. The drier corn will have a tendency to offset the sourness due to the sorghum. On the other hand, some farmers, upon finding their corn for the silo too dry, have added a little sorghum on account of its having more "juice" in it, thus making sure that their silage would not be so dry as to mold. Quite a number of extensive cattle feeders have made the statement that for making beef they would just as soon have silage made from corn and sorghum, half-and-half, as silage from corn alone. Sorghum, like corn, should be mature; the seed should ripen before the plant is put into the silo.

**Kafir.** There are sections where the drought-resisting kafir grows as well as, or better than, ordinary field corn, and there it is recommended for the silo. It was found at the Kansas Station that kafir silage ranks second to corn silage as a milk producer. The plant seeds heavily and has abundant foliage, yielding from one third to one half more tonnage per acre than corn and about the same as sorghum. Kafir, like sorghum, should be mature before being put into the silo. Feterita, another one of the sorghums, also makes good silage.

**Cowpeas.** All of our common field legumes, such as clover, alfalfa, soybeans, and cowpeas have been tried out in the silo and can all be used, but the resulting silage is of an inferior quality. This is particularly true of clover and alfalfa, but cowpeas make fairly good silage especially if mixed with corn. All the legumes, when siloed singly, undergo a change that gives them the appearance of having rotted; when siloed with some other crop like corn or sorghum they do not show this "rotted" condition. Moreover by mixing the nitrogenous cowpeas with corn which carries a high per cent of carbohydrates, there is produced a richer, more growth-making feed. The proportion should be 1 load of cowpeas to 2 of corn.

However, every man who feeds silage should, if possible, feed some legume hay with it, in which case it is advisable to refrain from putting cowpeas into the silo. It is not an uncommon practice to feed silage straight without any hay, but stock, when fed silage, nearly always do better if they have access to some leguminous hay.

## How to Determine the Weight of Silage in the Silo

Sometimes we like to know how many pounds or tons of silage remain in the silo after we have begun feeding. Feeders have been heard to say: "If I had known that my silage would run out before grass was good enough for pasture, I should have fed a little lighter." Sometimes, too, when the silage is partly used out of a silo, we wish to sell the remainder. The accompanying table (from Wisconsin Bulletin 59) shows the computed weight of well-matured corn silage at different distances below the surface, and the total weight to those distances, 2 days after filling.

To illustrate: Suppose John Blank has a silo 16 x 32 feet inside dimensions. This silo, after the silage settled, contained 24 feet of silage. He fed out 14 feet of silage from the top, leaving 10 feet remaining in the silo which he wished to sell to a neighbor. How many tons had he to sell?

From the table it will be seen that one square foot of silage to a depth of 24 feet weighs 862 pounds. One square foot of silage to a depth of 14 feet is 407 pounds. Since this 14 feet has been fed out, subtract 407 pounds from 862 pounds which leaves 455 pounds, the weight of 1 square foot of the silage from a depth of 14 feet to the bottom of the silo, a distance of 10 feet. Then, if we multiply this 455 by the number of square feet in the surface area of the silage, the product will be the number of pounds of silage remaining in the silo. In order to find the number of square feet in the top surface of a silo, find the diameter, take half of it, multiply it by itself, and multiply this product by 3.1416. The diameter of Mr. Blank's silo is 16 feet; half of this is 8 feet; eight times 8 equals 64; 64 times 3.1416 equals 201.06 square feet, the area of the top surface of silage in the silo. Multiplying 455 by 201.06, we get 91,482.3 pounds, the weight of silage remaining in the silo. Dividing this by 2,000 (the number of pounds in a ton) we have 45.74, the number of tons of silage Mr. Blank has for sale.

WEIGHTS OF SILAGE AT DIFFERENT DEPTHS

| DEPTH OF SILAGE | WEIGHT PER CUBIC FOOT AT DIFFERENT DEPTHS | TOTAL WEIGHT TO DEPTH GIVEN OF 1 SQ. FT. | DEPTH OF SILAGE | WEIGHT PER CUBIC FOOT AT DIFFERENT DEPTHS | TOTAL WEIGHT TO DEPTH GIVEN OF 1 SQ. FT. |
|---|---|---|---|---|---|
| Feet | Lbs. | Lbs. | Feet | Lbs. | Lbs. |
| 1 | 18.7 | 18.7 | 19 | 45.0 | 619.7 |
| 2 | 20.4 | 39.1 | 20 | 46.2 | 665.9 |
| 3 | 22.1 | 61.2 | 21 | 47.4 | 713.3 |
| 4 | 23.7 | 84.9 | 22 | 48.5 | 761.8 |
| 5 | 25.4 | 110.3 | 23 | 49.6 | 811.4 |
| 6 | 27.0 | 137.3 | 24 | 50.6 | 862.0 |
| 7 | 28.5 | 165.8 | 25 | 51.7 | 813.7 |
| 8 | 30.1 | 195.9 | 26 | 52.7 | 966.4 |
| 9 | 31.6 | 227.5 | 27 | 53.6 | 1,020.0 |
| 10 | 33.1 | 260.6 | 28 | 54.6 | 1,074.6 |
| 11 | 34.5 | 295.1 | 29 | 55.5 | 1,130.1 |
| 12 | 35.9 | 331.0 | 30 | 56.4 | 1,186.5 |
| 13 | 37.3 | 368.3 | 31 | 57.2 | 1,243.7 |
| 14 | 38.7 | 407.0 | 32 | 58.0 | 1,301.7 |
| 15 | 40.0 | 447.0 | 33 | 58.8 | 1,360.5 |
| 16 | 41.3 | 488.3 | 34 | 59.6 | 1,420.1 |
| 17 | 42.6 | 530.9 | 35 | 60.3 | 1,480.4 |
| 18 | 43.8 | 574.3 | 36 | 61.0 | 1,541.4 |

# INDEX OF SUBJECTS

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FIG. 643. A well-made loose stone wall or fence. See page 492

# APPENDIX

# Practical Farm Fence Construction

*By* PROFESSOR H. C. RAMSOWER *of the Department of Agricultural Engineering of the College of Agriculture of Ohio State University, who was born and raised on a farm in Licking County, that state, and whose close contact with practical conditions is indicated by the fact that since 1909 he has managed his own farm. After graduating from the college in which he now teaches, he took special courses in Mechanical and Civil Engineering, having his present work in mind even at that time. In addition to developing his department he has traveled extensively through farming communities; was for 5 years Professor of Agronomy; has written a text book on Farm Equipment; and has made a special study of farmstead improvements.*—EDITOR.

THE prices of all kinds of fence materials have been steadily advancing during the last two decades and conditions created by the late war brought them to a level scarcely dreamed of a few years before. From this level they will probably not greatly recede. The problem of fencing the farm, therefore, has become more serious than ever and hence more deserving of careful study.

**Amount of fence should be reduced.** The total number of rods of fence on the average farm could and should be materially reduced. It is frequently an unnecessary expense to fence fields used in a regular crop rotation. If pastured at some time during the rotation, fences are seemingly necessary but it might be more economical to provide a permanent pasture if by so doing the amount of fence to be built and maintained could be reduced.

**Fence repair.** The average farmer will readily recognize that the old adage, "A stitch in time saves nine" is nowhere more applicable than in connection with farm fence. It is a splendid custom to have handy a tool box with nails of different sizes, a hatchet, a pair of pliers and a small saw so that it can be set in the wagon or auto when trips are made over the farm. A loose board on a gate may need tightening, a panel in a fence may need straightening, or a wire may need to be spliced, each of which tasks done in time is of small moment, though it may save hours and dollars later. Frequent whitewashing or painting of gates, especially around the farmstead, is much to be desired and not only adds to the life of the structures but gives a touch of neatness and finish that brings a certain return in dollars and cents.

**Essentials of a good fence.** A good fence is one that serves long and well the purpose for which it was built. Beauty rather than utility may have been the primary requisite as in the construction of a lawn fence. Or, utility may have been the only consideration as in the construction of a brush fence to turn sheep. Or, again—and this is most frequently the case—the good fence must both

## Farm Fences in the United States

PERCENTAGE OF VARIOUS TYPES USED IN CERTAIN SECTIONS

| AREA | WOVEN WIRE | | BARBED AND SMOOTH WIRE | HEDGE | WOOD | STONE |
|---|---|---|---|---|---|---|
| | HIGH (OVER 42 IN.) | LOW WITH BARBED WIRES | | | | |
| Western Dak., Kan. and Neb. and northern Minn. | 5.5 | 10.2 | 84.0 | 0.03 | 0.3 | 0.0 |
| Eastern Dak., Kan. and Neb. and southern Minn. | 8.8 | 20.0 | 63.0 | 6.4 | 0.6 | 0.6 |
| Iowa | 8.0 | 45.5 | 43.5 | 2.1 | 0.9 | 0.0 |
| Missouri | 13.8 | 49.4 | 27.2 | 5.6 | 3.8 | 0.04 |
| Wisconsin | 13.5 | 33.4 | 49.8 | 0.04 | 2.3 | 0.8 |
| Illinois | 11.4 | 41.7 | 29.0 | 12.4 | 5.5 | 0.0 |
| Michigan | 55.9 | 11.8 | 11.9 | 0.6 | 19.7 | 0.0 |
| Indiana | 53.3 | 18.0 | 12.9 | 1.6 | 14.1 | 0.05 |
| Ohio | 59.8 | 3.8 | 7.0 | 1.2 | 27.9 | 0.05 |

From Bul. 821, U. S. Department of Agriculture, 1916.

serve its utilitarian purpose well and also harmonize with, and serve to enhance the beauty of, the farm and the farmstead. A good fence, therefore, is one that is built of strong, durable material and that is possessed of a measure of beauty.

## Types, Materials, and Construction

**Brush fence.** The brush fence was used in early days when the land was uncleared and when the space occupied by the fence was not important. It served especially well in confining sheep. Except in the more sparsely settled regions where timber abounds it is no longer to be considered. It harbors insects and vermin and is a menace from fire.

**Root fence.** The root fence really followed the brush fence and represented a further stage in the clearing of land. The stumps and roots had to be piled in preparation for burning and it was generally desirable to leave them in piles for a year or so until they became thoroughly dry. It was quite natural, therefore, that they should be piled into fence rows to serve a real purpose against the time when they should be burned and replaced by a better fence.

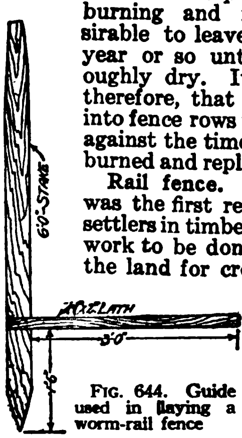

FIG. 644. Guide used in laying a worm-rail fence

**Rail fence.** The worm-rail fence was the first real fence built by early settlers in timbered regions. The first work to be done was that of clearing the land for crops and generally the best of the timber was split into rails. It is not uncommon even now to find on farms black walnut rails large, straight and in a perfect state of preservation though in continuous outdoor service for three quarters of a century or more. Rails were generally cut in 12-foot lengths with the diameter approximately 4 to 6 inches. A rail is nearly always larger at one end than at the other so that in laying up a fence the small end should always be laid forward to keep the corners of even height.

The laying of a worm-rail fence must proceed in a systematic way if the line is to be straight and the worm regular. Stakes should be set along the middle line throughout its length. A guide (Fig. 644) is then constructed by nailing a lath a little more than 8 feet in length at right angles to and about 18 inches from the bottom of a 6-foot stake. With the stake set on the middle line and the lath at right angles to it, the end of the lath marks the point where a corner should fall. With the rails lapping about one foot a 12-foot rail will thus lay a panel about 8 feet long. A narrower worm could be used which would increase the panel length but the fence would not stand so erect and would be more easily blown over.

*Ground-chunks* are generally laid beneath the corners. They serve to keep the rails from coming in contact with the ground and to increase the height of the fence. These chunks are about 2 feet long and from 8 to 12 inches in diameter being usually knotty portions of the tree or small logs, that are hard

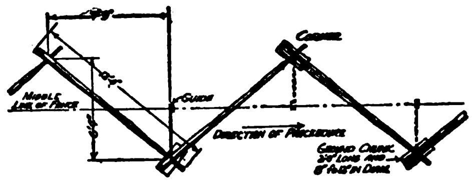

FIG. 645. Diagram of a section of rail fence to show distances, construction, use of guide, etc.

to split. If the fence is used to confine hogs either the ground chunks must be omitted or pieces of rails must be laid under the fence.

Eight rails are usually required to lay the fence to the proper height. It can be made more secure by laying short rails on top of the fence and across the worm and locking them in place by still shorter pieces. Or, just the corners may be locked by setting pieces the height of the fence in the corners. Sometimes stakes and riders are utilized to make the fence still higher. Cross stakes are set at the middle of each panel then rails laid from one set of stakes to the next. Sometimes where locks are not used, the top 3 or 4 rails are wired together to prevent stock pushing them off.

While this type of fence served its purpose well when land was cheap it occupies so much space as to be objectionable on high priced land. Also it is easily blown over especially following a rain when the rails are wet and slippery. Then, too, the fence row tends to grow up to weeds, briers and underbrush, and harbors insects and rodents.

The post-and-rail fence (Fig. 646*b*) followed the worm fence in development as it made more economical use of the rails. The posts were mortised and the rails flattened at the ends and slipped into the mortises as the posts were set. A five-rail fence of this kind is sufficiently high, occupies less ground than the worm-rail fence, will not blow over and will last for the life of the posts. The tedious work of mortising the posts may be done away with by wiring the rails to the posts (Fig. 646*a*). A No. 10 or 11 galvanized wire is passed through a staple in the top of the post, carried to a point near the ground and stapled to the post. A rail is then placed between the post and the wire which is then drawn up tightly and stapled above the rail. The second rail is then placed and the wire stapled, and so on to the last rail. Two men are needed in erecting this fence, but it is found very satisfactory.

**Hedge fence.** A wide difference of opinion exists as to the desirability of the hedge fence for farm use. It unquestionably has its disadvantages. It is rather difficult to get started and several years are required for its growth; it requires prompt and careful trimming at least twice each year; it robs the soil of both fertility and moisture for several feet on either side; it becomes unsightly if not properly cared for; and once beyond control it is a long hard task to cut it down and grub out the stumps. On the other hand, the good hedge fence properly set, correctly trained, and carefully trimmed is an everlasting fence which does not decay, does not blow over, is not crowded over by stock (which it will not injure) and adds beauty and freshness to the landscape. However, the good hedge fence is the exception rather than the rule.

The osage orange is universally used for hedge fence. It is a fairly rapid growing plant, hardy, not very susceptible to insect injury, produces heavy foliage and is sufficiently thorny to repel the advance of stock. Sheep will sometimes though not often, eat the foliage. Plants may be obtained from nurseries.

The first step in setting out a hedge fence is to clear the old fence away, plow a strip at least 4 feet wide, and thoroughly fit the soil. Plants will generally do better if set in the spring of the year although fall setting will give fair results if a moist time is chosen. A line should be stretched accurately along the fence line and a shallow furrow drawn with a hoe. The plants are then set 6 inches apart, water being used the same as in garden planting. A temporary fence must be placed next to the hedge as the plants must be carefully protected for three years at least. Meanwhile they should be cultivated and missing plants should be replaced the second year.

An old method of training the plants so as to secure a tight bottom to turn hogs and sheep consists of binding the plants down at an angle of approximately 45 degrees from the vertical and fastening them in this position during the third or fourth season. The branches should then grow upright making a fairly tight bottom for the hedge. However, this is a slow, difficult task and not always a successful one.

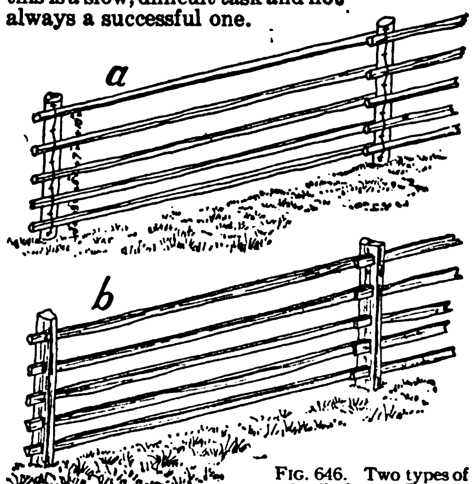


FIG. 646. Two types of post-and-rail fence. The use of wire in *a* does away with the mortising of the posts in *b*

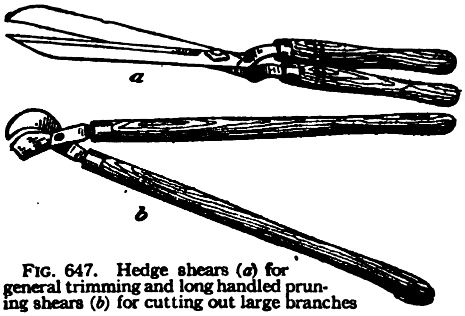


FIG. 647. Hedge shears (*a*) for general trimming and long handled pruning shears (*b*) for cutting out large branches

A better though somewhat more expensive plan is to erect a 30-inch woven wire fence close to the hedge during its third year, with posts set every 30 feet along the hedge line. To insure that the plants will stand erect, two or three smooth wires are stretched along the side opposite to the fence and fastened both to the posts and to the fence too if necessary. It is especially desirable to have such a wire near the top of the fence as it helps to hold the hedge plants more securely when they are being trimmed. This fence insures absolutely hog-tight construction.

A hedge will generally need its first pruning the fourth season and this should not be neglected as it will cause the plants to branch more freely. For trimming use a large pair of hedge shears, a pair of long handled pruning shears, and a hedge knife or corn cutter, the latter being the better if the hedge is trimmed frequently enough to keep the branches small.

A hedge should not be allowed to grow higher than 4 feet. Even the most unruly stock will seldom attempt to jump a hedge of this height and a higher one is more difficult to trim. There is a tendency to leave a hedge a little higher at each successive trimming, so usually it is necessary every 3 or 4 years to take heavy pruning shears and cut the top of each plant back to a proper height. Side branches should also be carefully trimmed so as to keep the fence narrow—a width of 8 or 10 inches being enough. One man can trim 25 to 40 rods of such a hedge in a day. A hedge should be trimmed regularly in June and September in the Central states.

**Stone fences.** In regions where there is an abundance of stone, more particularly limestone and sandstone, this material may be utilized in fence building. A neat and most effective wall can be laid with flat stone if made some 2 feet thick at the bottom tapering to 10 or 12 inches at the top. Large stones reaching through from one side to the other should be laid at frequent intervals especially near the top to bind the wall into one solid mass. Smaller stones can be used as fillers on the inside. (See Fig. 643.)

The height of such a wall is seldom more than 4, and frequently not more than 3 or 3½ feet. Sometimes the fence is finished by setting a row of large stones on edge along the top. This gives a more jagged and forbidding appearance, and the stones thus set are not so likely to be dislodged as when laid in a flat position. This kind of fence is common in the New England States (where, however, field boulder walls are also common) and in some regions of the Middle West. The amount of labor required for its construction is out of all proportion to its value, unless the stones are in nearby fields and must be removed for agricultural reasons. Like the worm fence it takes up valuable space and becomes a weed-grown menace unless looked after. The regular masonry fence of cut and matched stone set in cement mortar is another type that is restricted to country estates and suburban homes. In beauty and permanence it is of course a desirable boundary along a highway, but its cost cannot be justified on purely practical grounds.

**Concrete rails.** These, in combination with heavy concrete posts, are used in only a limited way in fence construction. Where some general scheme of beautification is being followed they are sometimes advisable. The proper reënforcement of such rails so increases their cost as to make it almost prohibitive except on elaborate country estates, which are about the only places on which they are found. Where unusually strong paddock fences are desired heavy timber planks are to be preferred. In an occasional case of this sort heavy iron piping, not less than 3 inches in diameter, is used with large posts of either wood or concrete.

**Wire fence.** The table on page 490 shows that *woven wire* is by far the most common type of fence in the Middle West. If there were statistics to show the proportion of this to all other kinds of fence erected during the last 5 years it would probably be close to 100 per cent. The use of barbed wire is especially common in the Western states.

Although there is a wide variation in the size of wire used in woven fences, the modern tendency is to use No. 9 throughout. This makes a more expensive fence and one that is harder to erect, but its increased length of life more than offsets these disadvantages. The use of stay wires as small as No. 12 or No. 14 is to be discouraged.

### The Rusting of Wire Fencing

The rapid rusting of modern fencing wire has been observed by all users of woven wire fence. Scientists have long been searching for the cause, but as yet no satisfactory explanation has been offered, though there seems to be some evidence which tends to point to the modern method of making the steel from which the wire is manufactured. Years ago nearly all the steel used in making fencing wire was manufactured by the puddled iron process, in which the metal was carefully and thoroughly worked by hand. However, it was only after the introduction of the Bessemer and open hearth processes of steel manufacture that woven-wire fencing came into prominent use, largely because these processes made possible cheaper steel.

After steel is taken from the Bessemer converter or from the open-hearth furnace, it is poured into large molds and forms ingots of solid steel. It is then carried to the rolling mills and reduced by constant rolling to a size approaching that of a lead pencil; finally it is drawn cold through appropriate dies and gradually reduced to wire of the desired size.

To *galvanize* steel fence wire is to coat it with a layer of zinc. The wire to be galvanized is first drawn through an oven to properly anneal it. Thence it is placed into a tank of weak acid to clean it properly, and to provide a soldering solution. Next it is drawn through a tank of molten zinc, a portion of which clings to it. Finally the wire is drawn through asbestos wipers in order to produce a uniform coating. Undoubtedly the thickness of the zinc coating is a factor in the lasting quality of the wire.

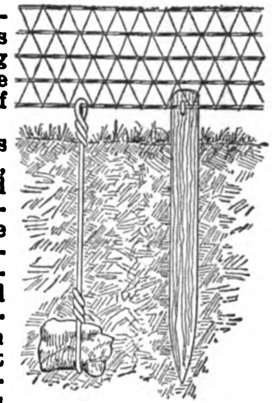

FIG. 648. Two methods of anchoring a wire fence between posts and in low spots

In spite of this coating, however, the wire rusts, and investigations carried on by the United States Department of Agriculture in 1905 and reported in Bulletin No. 239 seem to indicate that the element manganese, which is added to the steel, whether made by the Bessemer or the open hearth process, just before it is poured from the furnace, is at the bottom of the trouble. When a wire rusts it pits, and an explanation frequently given, though not yet regarded as an established fact, is that the pitting is due to electrolytic action set up because of the unequal distribution of manganese in the wire. The fact remains that modern fence wire does rust out rapidly, though it is believed that manufacturers are doing everything in their power to improve its quality. The farmer's chief protection lies in buying a fence made of nothing smaller than No. 9 wire; even larger sizes may be advisable.

The height of woven wire fencing varies considerably. What is known to the trade as a 10-47 fence, that is, one having 10 wires and measuring 47 inches in height, is most common in Ohio, Indiana, and Michigan. Such a fence, if intended for horses, is not complete without a barbed wire on top. The low fence, with 2 or more barbed wires, is most common in Iowa, Wisconsin, Missouri, and Illinois. It makes a good cattle fence, but where it is used to fence in horses it is somewhat more dangerous than the 47-inch fence with but one barbed wire on top.

Barbed wire should be used with the utmost care. The practice of placing it on old fences, and especially near the ground, when horses are to be pastured or inclosed, cannot be too severely condemned. Horses maimed and ruined for sale if not for service are to be found in every community where barbed wire is used. It has, to be sure, a real place on top of a well-constructed fence 42 or 47 inches high, but placed lower than this it is a serious danger.

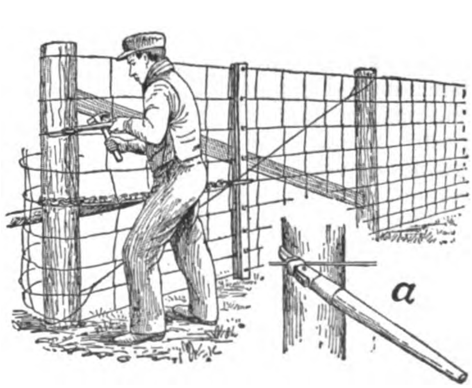


FIG. 649. Individual wire stretcher in use and (*a*) in detail to show how it grips and tightens a wire for stapling

When erecting a wire fence, one

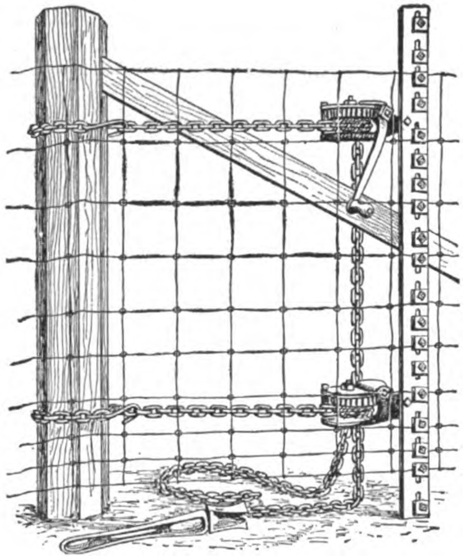

FIG. 650. Good type of wire fence stretcher with chains and windlass at both top and bottom of clamp-bar

should remember that it is to be in place for a number of years, and that the degree of tightness will determine in no small measure the length of its life. Every effort should, therefore, be made to secure it properly at both ends after stretching it as tightly as possible. Fig. 650 shows one of the best types of stretcher. The chains are fastened to the top and the bottom of the clamp-bar, each chain being controlled by a separate windlass. This makes it possible to keep the fence plumb, which is not possible when there is but one windlass. The clamp-bar should be so placed that it will stand about three feet from the end post when the fence is finally stretched. The fence should then be cut off and the wires tightened by means of an individual wire-stretcher (Fig. 649) as each is stapled to the post. The wires should be bent around the post and wrapped around themselves, as staples are usually not sufficient to hold them; if steel or concrete posts are used, the wires must, of course, be wrapped. This is a rather difficult task, but it may be accomplished in such a way that there is but little slack in the fence after the stretcher is removed.

Home made wire fences were in much more common use several years ago than they are now, the extensively manufactured woven wire having virtually replaced them. In one home-made type a fence of 10 smooth wires was first erected. Then by means of special tools either wire or wood vertical stay-rods were woven into the fence at intervals of from 1 to 4 feet. This type, as well as others of similar design, was quite satisfactory, but labor is now so scarce and so high that the individual can scarcely compete with the large factory, especially if any considerable amount of fence is needed.

Wire fence is, of course, stapled to the line posts if of wood. To concrete or steel posts it is fastened in a number of ways (Fig. 651). In A, which is the most common method, the fastening wire is passed around the post. In B it is looped over the line wire, passed through a hole in the post then bent around either side of the post and fastened to the line wire. The sketch at D shows a fence locked in place by a No. 9 locking wire run through staples put in place as the post is made. In any case only about half the wires are fastened to each post. In the case of one patent concrete post (*c*), the fence is fastened with staples driven into a strip of composition cement cast in the face of the post when molded, and which takes and holds a staple well. Wood rails for a picket fence or boards are sometimes nailed to posts of this sort.

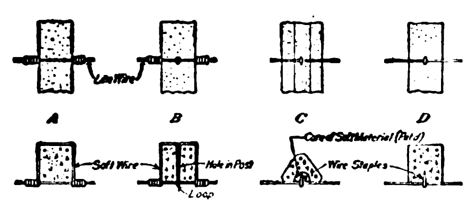


FIG. 651. Four methods of fastening wire fencing to concrete posts (see text). Upper figures show front view; lower figures show sections across posts

Fig. 656 shows two common methods of fastening wire to steel posts. In *a* the fastening wire is wrapped around the post; *b* shows a round, galvanized iron

post in which small ears are partially cut out of the face of the post and bent around over the wires. Sometimes a staple is inserted through a hole in the post and clinched; and in another case in which the post is triangular in shape horizontal grooves are cut part way through the post along the apex of the triangle. Each line wire is then slipped into one of these grooves and a nail is dropped in between it and the back of the post, that is, on the inside of the triangle.

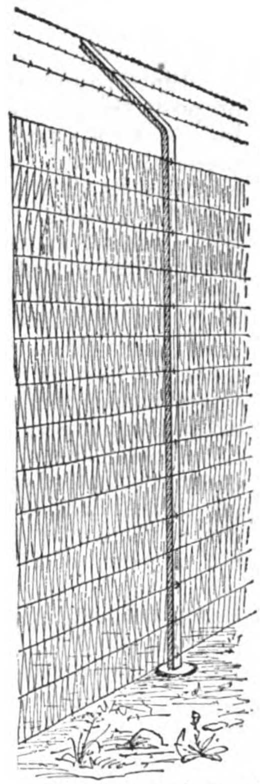

FIG. 652. A fence of woven and barbed wire and steel posts, useful where extra security is desired

### Wooden Fences

**Board fence.** The comparatively small amount of regular field fence now made of boards finds its chief use about barn yards where wire fence can scarcely be used with safety. The panels are usually 14 feet long with posts 7 feet apart. The boards are generally 1 by 5 inches and may be sawed from local timber, either hard or soft wood serving the purpose.

The regular field fence is 5 boards high spaced from bottom to top as follows, 3, 5, 7 and 10 inches. The bottom board is placed 3 inches from the ground if hogs are to be confined. If the fence is to turn only grown horses or cattle the bottom board may be omitted. Joints should be broken, that is, some of the boards should lap from one panel to the next, to give a more rigid construction.

**Picket fence.** This, like board fence, is no longer generally used in the field. It has, however, a real place around gardens and farmsteads. The patterns after which it is built vary greatly and can be made to suit the individual taste of the owner.

A **picket-and-wire fence** is occasionally used for field purposes. In one type 3 double strands of No. 12 wire are stretched and loosely stapled on posts one rod apart. The upper pair is placed so as to fall 6 inches below the top of the pickets, the lower, 6 inches above the bottom, and the middle pair half way between. The pickets are then woven into these wires. A special wrench is provided to twist the wires between the pickets which are spaced 2 to 2½ inches apart. A string may be stretched along the top line of the pickets so as to secure an even line. If the pickets are of equal length a board may be placed on the ground beneath each panel and the pickets placed upon it to give an even line at both top and bottom.

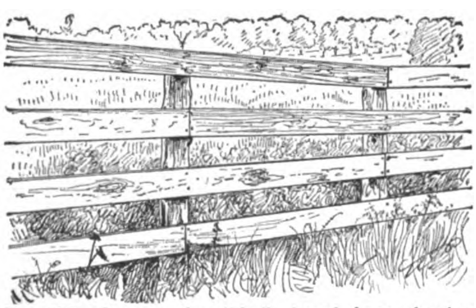

FIG. 653. Section of well-built board fence showing broken joints and good spacing

Pickets for this type of fence are usually sawed ½ by 2 inches and 4 feet long. Local hard wood such as beech, maple, chestnut, oak, etc., may be used.

The *wood-rail* picket fence is still more common. The rails are generally 2 by 4 inches by 14 feet, two being used for each panel; the posts are set 7 feet apart. The pickets are generally ¾ inch by 3 or 4 inches by 4 feet, but for lawn purposes they may be narrower and shorter.

**Portable fences.** It is sometimes convenient or necessary or both to have a portable fence. It may be used in a barn lot or for confining stock, especially sheep or hogs, on temporary pasture. One good type in common use is shown in Vol. I, Fig. 89. Hurdles of chestnut or other hard wood, about 7 feet long, the posts of which are driven into the ground and held together with long oak pins, are frequently seen on Eastern farms and estates. They are highly satisfactory for confining horses and for enclosing exercising rings, race tracks, etc. They are not as easily moved as the sheep hurdle just referred to, and they are of course unnecessarily heavy and high for confining hogs, sheep or other small animals.

Where the custom of hogging down corn is followed and it is found desirable to fence off a part of a field, a 24-inch woven wire fence may be unrolled, set up along a corn row and tied to the standing corn. If a supply of old fence rails is at hand they may be used to good advantage in building temporary fences.

## Fence Posts

FIG. 654. How a heavy cross piece is used to anchor a fence post

Since from 85 to 95 per cent of modern fence is built on posts the question of post material is of vital importance. Fence posts may be made from either of three materials: wood, steel, or concrete, but the type to choose is not easily determined.

**Wood posts.** Wood has been the most common fence post material in past years and no doubt will continue in the lead for several years to come. The kind of wood used in a given locality will be determined in part at least by the kind of timber common there. Yet some woods formerly much used for posts have become so valuable for other purposes that as post timber they have been largely replaced by other kinds even though the latter must be shipped in from a distance.

The relative durability of the common post timbers has been investigated only in a limited way. The accompanying table is the summary of a study made in the central part of the United States by the Department of Agriculture. For purposes of classification the region was divided into

AVERAGE LIFE AND COST OF DIFFERENT KINDS OF FENCE POSTS USED IN THE MIDDLE WESTERN STATES

| KIND OF POST | AVERAGE LIFE | | AVERAGE COST IN ALL AREAS | | AVERAGE COST IN EACH AREA | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | NO. 1 | | NO. 2 | | NO. 3 | | NO. 4 | |
| | NUMBER ESTIMATED | YEARS | NUMBER ESTIMATED | CENTS | NUMBER ESTIMATED | CENTS | NUMBER ESTIMATED | CENTS | NUMBER ESTIMATED | CENTS | NUMBER ESTIMATED | CENTS |
| Osage orange . . | 789 | 29.9 | 774 | 22 | 105 | 25 | 326 | 24 | 320 | 17 | 23 | 18 |
| Locust . . . . | 464 | 23.8 | 465 | 24 | 501 | 26 | 21 | 22 | 29 | 18 | 14 | 18 |
| Red cedar . . . | 557 | 20.5 | 574 | 29 | 346 | 29 | 97 | 31 | 104 | 27 | 27 | 21 |
| Mulberry . . . | 88 | 17.4 | 82 | 19 | 45 | 20 | 25 | 17 | 12 | 15 | | |
| Catalpa . . . | 48 | 15.5 | 45 | 17 | 15 | 17 | 17 | 17 | 13 | 18 | 10 | 18 |
| Burr oak . . . | 97 | 15.3 | 90 | 15 | 10 | 10 | 54 | 15 | 26 | 15 | | |
| Chestnut . . . | 94 | 14.8 | 91 | 15 | 91 | 15 | | | | | | |
| White cedar . . | 1,749 | 14.3 | 1,709 | 18 | 642 | 18 | 459 | 18 | 374 | 19 | 274 | 16 |
| Walnut . . . | 60 | 11.5 | 56 | 13 | 6 | 5 | 11 | 13 | 39 | 12 | | |
| White oak . . | 1,242 | 11.4 | 1,218 | 12 | 333 | 14 | 389 | 11 | 421 | 12 | 75 | 13 |
| Pine . . . . | 41 | 11.2 | 37 | 18 | 12 | 23 | 7 | 22 | 3 | 11 | 15 | 12 |
| Tamarack . . . | 67 | 10.5 | 64 | 9 | 6 | 16 | 26 | 8 | 7 | 9 | 25 | 9 |
| Cherry . . . | 9 | 10.3 | 9 | 8 | 7 | 8 | 2 | 8 | | | | |
| Hemlock . . . | 10 | 9.1 | 9 | 12 | 3 | 20 | 6 | 8 | | | | |
| Sassafras . . . | 19 | 8.9 | 17 | 14 | 11 | 15 | 6 | 10 | | | | |
| Elm . . . . | 15 | 8.8 | 15 | 12 | 6 | 10 | 5 | 9 | 4 | 15 | | |
| Ash . . . . | 69 | 8.6 | 58 | 10 | 17 | 11 | 2 | 10 | 15 | 10 | 24 | 10 |
| Red oak . . . | 22 | 7.0 | 24 | 7 | 6 | 7 | 10 | 8 | 8 | 4 | | |
| Willow . . . | 41 | 6.2 | 33 | 7 | 1 | 12 | 2 | 7 | 25 | 7 | 5 | 9 |
| Concrete (estimated) . . . | 42 | 48.0 | 121 | 30 | 53 | 30 | 48 | 29 | 19 | 31 | 1 | 35 |
| Stone . . . . | 11 | 36.3 | 15 | 35 | | | | | 4 | 38 | 11 | 35 |
| Steel (estimated) . | 131 | 29.9 | 219 | 30 | 82 | 30 | 71 | 29 | 54 | 30 | 3 | 30 |

From Bulletin No. 321, United States Department of Agriculture, 1916.

areas as follows: No. 1, Ohio, Indiana, and Michigan; No. 2, Wisconsin and Illinois; No. 3, Iowa, Missouri, southern Minnesota, eastern Kansas, and eastern Nebraska; No. 4, northern Minnesota, the Dakotas, western Kansas, and western Nebraska. The results are based only on common practice and are not claimed to be scientifically accurate.

From the standpoint of durability osage orange is really in a class by itself with locust and red cedar following, there being no great difference in the lasting qualities of these two. It is generally considered that a post timber which shows an average life of less than 10 years should not be given serious consideration.

The Ohio Agricultural Experiment Station published in Bulletin 219 (1910) the results of personal examinations of over 30,000 fence posts located in 292 different kinds of fences. This investigation rates post timbers in the order of their durability as follows: osage orange, locust, red cedar, mulberry, white cedar, catalpa, chestnut, oak, and black ash, which is very similar to the arrangement based on the Department of Agriculture's investigation.

The Ohio Bulletin gives the following general conclusions based on the results of the investigation:

1. There is no difference which end of the post is put in the ground except that the larger end should have preference.
2. From data collected so far, seasoning does not seem to have any marked effect on durability. It is hoped that the matter will be investigaged further.
3. Timber that grows rapidly in the open is not so good as that of the same variety grown in the woods.
4. There is some evidence that it is not good to cut posts just as a tree begins to grow in early spring.
5. The wood at the centre of the tree is not so good as that just inside the sap wood.

## Preservative Treatment of Wood Posts

There is no question but that the life of posts can be prolonged by proper treatment and some of the methods used are perhaps worthy of trial on many farms. Rotting is caused by the growth of fungi, or low forms of plant life, which feed upon the tissues of the wood. They require heat, light, moisture, and food for their development, all of which conditions are supplied near the surface of the ground; wherefore posts rot off at this point. A post rots but little beneath the surface of the ground because the lack of air prevents the growth of fungi there, while above ground the lack of moisture prevents their growth. It is not possible to control the moisture, the heat, nor the air supply, but if the food supply can be cut off the fungi cannot develop. The most feasible method of destroying the food supply is to fill the tissues of the wood with creosote, a coal tar product.

This method is best carried out by heating the creosote in a large kettle, setting well-seasoned posts into it, leaving them there for an hour or so, and then removing them to a kettle of cold creosote where they are left for several hours. During this time the liquid soaks into the posts, the depth depending upon the nature of the wood. The hot bath is of itself fairly effective, but the cold bath following is essential to a thorough treatment. Painting the lower portion of the posts with hot creosote will probably prolong their life long enough to pay for the treatment, the estimated cost of which is about 15 cents per post. When the cheaper timbers are used it may reasonably be expected that it will double or even treble the life of the post. It probably will not pay to treat the better classes of hardwood posts, since the denseness of the wood prevents the absorption of the creosote in beneficial quantities.

Charring the post is a very effective method of preventing decay. To do it place that portion of the post which is to go into the ground in a bed of hot coals and leave it until thoroughly charred. This process also destroys the food supply of the fungi and prevents their getting a start.

FIG. 655. Home-made outfit for treating wood posts with hot creosote

Painting the lower portion of the post with an oil paint is effective so long as the paint lasts, but it soon scales off. The beneficial effects of this treatment are probably not worth the time and trouble it takes.

Zinc chloride has sometimes been re-

commended as a preservative but it is little used. It is usually applied by boring holes in the posts and filling the holes with the solution, which is slowly absorbed by the wood. Being easily soluble, the solution next the surface of the post soon loses its effectiveness.

The table at the right, from Circular No. 117, United States Department of Agriculture, illustrates the value of the preservative treatment of lodgepole pine posts in Idaho. It should be remembered that the posts treated were of pine which, being a soft wood, absorbed a relatively larger amount of the preservative than would a hard post. The value of the treatment would, therefore, be greater for soft than for hard woods.

| PER POST | UNTREATED | TREATED |
|---|---|---|
| Initial cost | $0.06 | $0.06 |
| Cost of treatment | .00 | .15 |
| Cost of setting | .12 | .12 |
| Total cost set | .18 | .33 |
| Estimated length of service (years) | 4 | 20 |
| Annual cost (allowing 6 per cent interest on investment) about | 0.05 | 0.03 |

**Steel posts.** Steel posts have been in more or less common use for 15 or 20 years. During this time both their material and their form have been widely changed so that there are now a great many different designs on the market. It is impossible to say which type will prove most satisfactory for all conditions.

The V-shaped post made of soft steel about ⅛ inch thick is likely to rust at the top of the ground in a few years. Furthermore, it is rather easily bent and, once bent and straightened, it seldom possesses its former strength.

The round galvanized steel post seems to last fairly well but bends quite easily. Other forms of the galvanized post have been designed to remedy this weakness but with indifferent success.

The high carbon, stiff steel post seems to be giving a large measure of satisfaction. It will spring back to shape if bent and in many designs at least is supplied with an enlarged bearing surface in the form of a wing beneath the surface of the ground which tends to hold it erect even though a strain comes upon it when the ground is wet.

Nearly all steel posts are easily driven by means of a sledge hammer, which makes it possible to set a long line of them in a very few hours—a decided advantage. The best way to set steel posts is to load them in a wagon, proceed along the line of the fence and drive the posts from the rear end of the wagon. A special driving cap is provided for driving most metal posts so that the top will not be crushed.

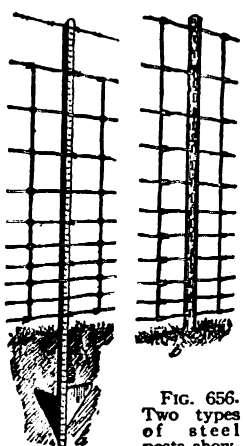

Fig. 656. Two types of steel posts, showing also two methods of fastening fence (see text)

**Concrete posts.** Because of its durability, concrete is a splendid material for fence posts for which purpose it will, without doubt, find a wide use in the future. The greatest care must be exercised, however, both as to choice of materials and as to their handling if success is to be assured. The materials required are cement, sand, gravel or crushed rock, and reënforcement. The cement must be one of the standard brands of Portland cement; natural cement should never be used. For directions for making concrete posts see Chapter 25.

The home-made cement post is not cheap in first cost. With cement at 40 cents per bag the cost for this item alone will be from 8 to 10 cents. The reinforcing material will cost about 10 cents per post at pre-war prices for steel. If sand, gravel and labor are taken into consideration the cost will run to a high figure. As a matter of fact it is a real question whether or not the farmer can afford to

make his own concrete posts when factories are so well equipped to do the work. It may be real economy to purchase the posts especially if a factory is near so that heavy freight rates are avoided.

In purchasing commercial posts one should, if possible, be assured by the experience of others, that the posts are giving satisfaction. The kind and method of reënforcement should be investigated as well as the materials used.

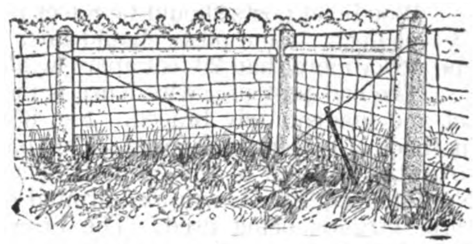

FIG. 657. A concrete fence corner unit which if well built should last 100 years

## Setting Fence Posts

The life of any fence requiring posts depends in large measure upon the kind of post used and the way in which it is set. Especially is this true of wire fence and inasmuch as 85 per cent. of fence now erected is of wire, chief consideration will be given to setting posts for this type.

Post holes should be dug in the spring season when the ground is wet if the most rapid progress is to be made. There is a variety of post hole diggers on the market. One of the best types is the auger with which a hole can be quickly dug if the ground is fairly moist and free from stones. A 16-inch ditching spade is a valuable tool for starting post holes.

Posts should not be set when the soil is filled with water, but they can be set much more easily if the soil is moist, *not wet*. If absolutely necessary to set them when the ground is really wet, do not stretch wire fence on them until the ground is more solid and they are more firm.

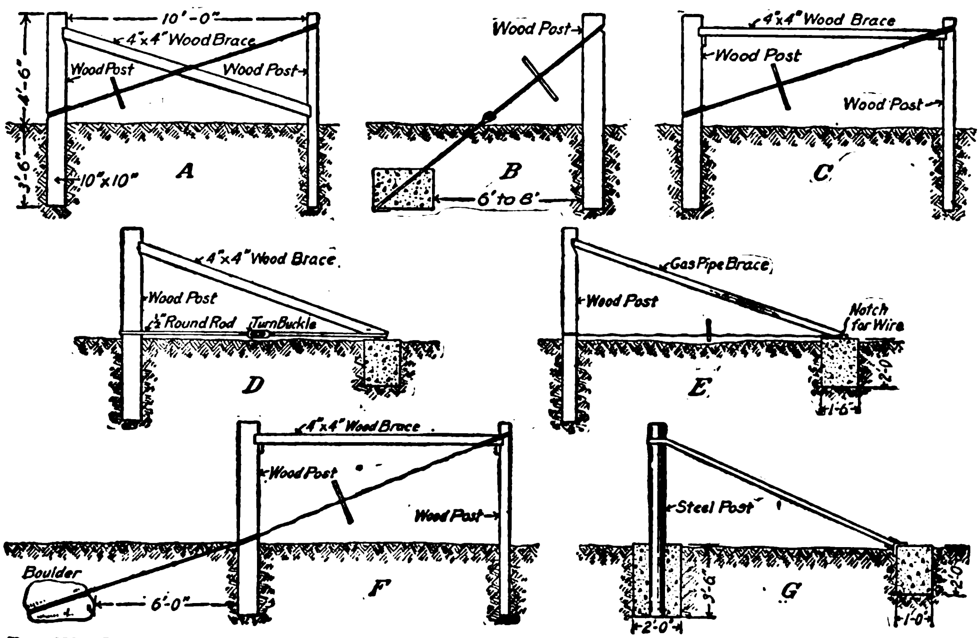


FIG. 658. Different methods of bracing end posts. The problem of making corner posts secure is solved by carrying out such methods of bracing as are shown here, but in two directions

Wood end posts should be 8 feet in length and should never be set less than 3½ feet deep. Line posts should be 7 feet long and should be set 2½ feet deep and never more than 20 feet apart, while one rod is better.

The end post in a wire fence is most important; too frequently it is poorly set and inadequately braced. Fig. 658 shows at *A* and *C* the most common methods of bracing end posts. The diagonal position of the brace at *A* will tend to lift the post out of the ground: hence, the construction shown at *C* is better. No. 9 fencing wire is wrapped around the post as shown, at least two and, better, three strands being used. The brace wires are then twisted to the proper tension.

The method shown at *F* is a good one if the brace wire going beyond the end of the fence, will not be in the way. In this case the wire itself is wrapped around a stone buried in the ground; sometimes a concrete "dead man" with a ½-inch iron rod embedded in it is used in place of the boulder. The objection to either of these methods is that the wire soon rusts off at the surface of the ground; however, a pipe may be slipped over the wire to protect it and prevent this for a time.

The braces shown at *D* and *E* are excellent, that at *D* being especially good in that it provides a way to tighten the brace when it becomes loose as it is sure to do. It is more expensive and more trouble to put in, hence is seldom used. Braces of this kind can be purchased from makers of steel posts. The wire in *E* soon becomes rusted so that it breaks easily if an attempt is made to tighten it.

Steel posts make excellent end posts; a method of setting a patented steel post is shown at G. The brace is of steel and fits into an angle-iron socket which rests on the corner of the concrete block. The upper end is attached to a ring clamp which slips over the post. The brace is tightened by pounding the ring clamp down on the post and fastening it by means of a bolt provided for that purpose.

Concrete end and corner posts are highly desirable. They may be molded separately and afterwards set in place and braced by any one of the methods shown. Fig. 657 shows a reinforced concrete corner post 8 by 8 inches, with concrete and wire braces to two other posts. Fig. 659 shows details of form construction for a braced concrete post made in place. The form can be easily taken down and used elsewhere. The brace may or may not be molded with the post; it is probably better to make it separate, in which case the post as well as the concrete footing should be recessed to receive the ends of the brace.

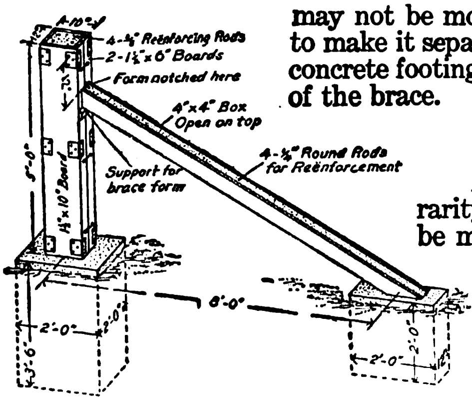

FIG. 659. Details and measurements for making a braced concrete end post. The form is hinged so that it may be set up and taken down with the least possible trouble and delay

## Gates

A neat, substantial gate well hung is a rarity on the average farm. A gate should be made of strong material but at the same time it must be reasonably light in weight. Several designs for home made gates are shown in Fig. 661.

At *A* is shown a common type of slide gate which may be quickly made of heavy, rough boards and satisfactorily hung in this way; it is, however, more difficult to open than a hinged gate.

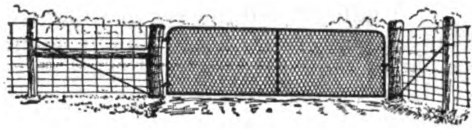

FIG. 660. A patent wire and metal pipe-frame gate hung on substantial, well-braced posts

The designs shown at *B* and *C* are excellent, well braced and substantial yet light in weight. Bolts, rather than nails, are used throughout. The hinges are large and heavy; it is always a mistake to use small hinges.

At *E* is shown an adjustable gate; that is, if the outer end sags it can be raised and held in position by adjusting the wires as shown. At *F* is shown another method of accomplishing the same result. At *G* is shown a mortised gate made of extra heavy materials. At *H* is shown a gate in which the boards are mortised into huge posts.

There are several types of patent gate on the market which have considerable merit. Those made of boards rather than of wire are in general to be desired. The wire gates usually have a steel pipe frame which if once bent out of shape is difficult to straighten. A wooden gate with a board or two broken is much more easily and quickly repaired than a damaged steel gate.

There are also various types of so-called self-opening gates and appliances which make it possible for one to open and close a gate without getting out of a vehicle. These are quite common in certain sections, both in home-made and ready made, patent styles. However, they are rather expensive and tend to get out of repair more readily than simpler gates.

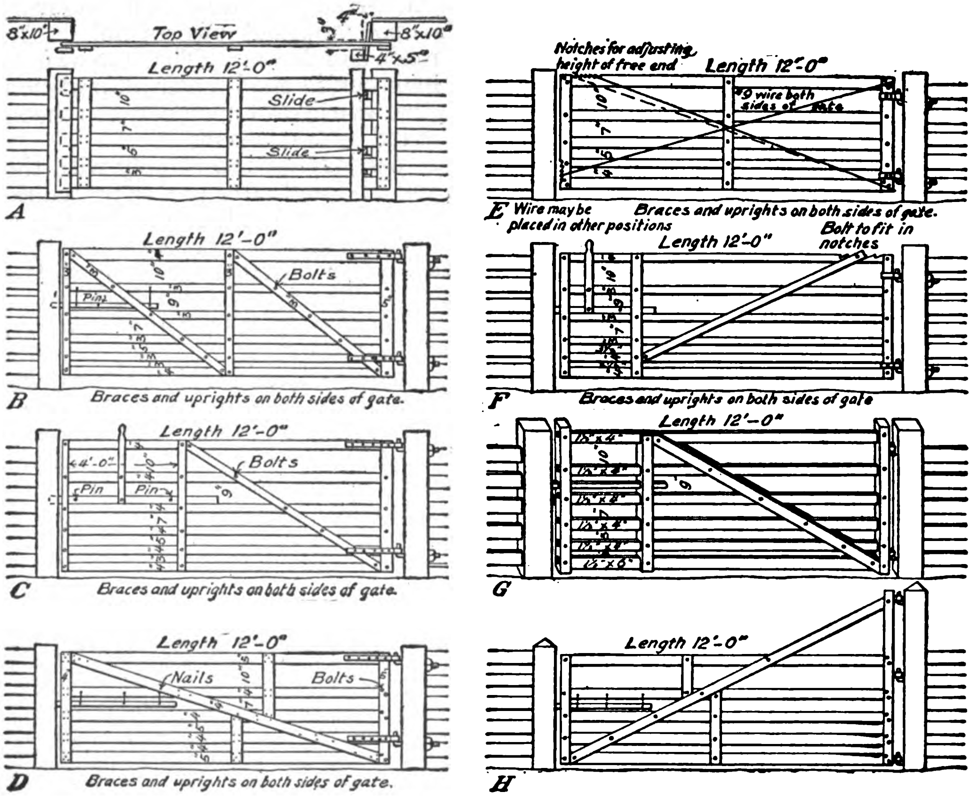


FIG. 661. Various types of farm gate that can be made at home. The constant usage to which a gate is subjected makes a strong, simple, and relatively light construction practically essential

A gate should always be hung to a large, well-set post. In boring holes for the hinges a vertical line should be drawn in the middle of the post by means of a plumb line. It is sometimes a good policy to set the bottom hinge ½ inch off of this vertical line on the side toward which the gate will open. This arrangement will tend to raise the end of the gate from the ground as it is being opened, a desirable thing to do, especially in winter when there is snow on the ground. Also, difficulties arising from the sagging of the gate are thus prevented.

## Legal Aspects of Fencing

Unfortunately but few states have comprehensive, well-defined laws relating to the construction and maintenance of farm fence. Aside from mere legal statements, custom and good practice (which should, of course, be the basis of equitable laws) dictate that the responsibility of line-fence construction and maintenance is a joint one between abutting property owners. In early range history it was necessary for freeholders desiring enclosed homesteads to fence out stock pasturing on the range. In the early history of states which had passed the free-range period it became necessary—as, indeed, it is the custom in many places even to-day—for owners of stock to fence their animals in. In the absence of such fences, owners were liable for damages done by their stock to property of adjacent freeholders.

Since livestock of some kind is now kept on virtually all well-managed farms the duty of constructing line fences rests upon adjacent owners alike. An extract from the laws of Ohio on this point reads as follows: "That the owners of adjoining lands shall build, keep up and maintain in good repair all partition fences between them in equal shares, unless otherwise agreed upon between them, which agreement must be in writing and witnessed by two persons."

The Ohio statutes further say that if any party refuses to comply with the above law the township trustees shall view the land and after proper procedure shall let the contract to build such fence, the cost being assessed against the offending party and, if not paid within 30 days, assessed against his property as taxes.

And again "No person or corporation shall be permitted to have any willow fence or any other line fence, except that known as the osage or blackthorn hedge, or construct or cause to be constructed a partition fence from barbed wire, unless written consent of the adjoining owner be first obtained."

Under the same statutes it is not necessary to obtain permission of the adjoining owner to use not more than two barbed wires if the lower one is not less than 48 inches from the ground and if they are placed on fence of some other material than barbed wire. It is, however, unlawful to permit a hedge fence to remain at a height of more than 6 feet for a longer period than 6 months.

All of these laws would seem to represent reasonable practice.

# FARM KNOWLEDGE

BUSINESS and home life on the farm are one and inseparable. This makes farming different from every other business, and the farm home different from every other home in the world. Has any farm family ever realized all it has to be thankful for—in its opportunity to get the best and the most out of living without going beyond the boundaries of its own home?

# FARM KNOWLEDGE

*A Complete Manual of Successful Farming Written by Recognized Authorities in All Parts of the Country; Based on Sound Principles and the Actual Experience of Real Farmers—"The Farmer's Own Cyclopedia"*

EDITED BY
E. L. D. SEYMOUR, B. S. A.

IN TWO VOLUMES

*VOLUME II. PART II. FARM LIFE*

Farming as a Business; The Farm Home, The Farm Family and The Farm Community; Farm Science in Simple Terms; Farming Facts, Figures and Opportunities

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# FARM KNOWLEDGE

## VOLUME II. PART II. FARM LIFE

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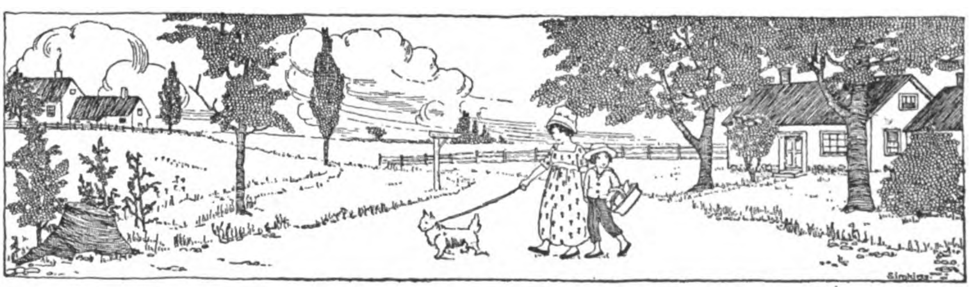

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He wishes, however, to thank especially those who have been associated with him in the actual building of the books. In connection with editorial matters these include Messrs. J. H. H. Alexander, F. H. Valentine, William L. Nelson, Albert Porter, C. O. S. Mawson, and Leonard Barron; in connection with the preparation of the illustration material, they include Messrs. B. F. Williamson, Howard L. Hastings and his associates, Eugene J. Hall, and the U. S. Department of Agriculture; in connection with the various manufacturing processes that attend the making of every book, they include all who have carried out, or enabled the Editor to carry out, the details upon which the successful development of the entire plan of the enterprise has so largely depended.

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*A List of the Men and Women Who Have Written This Volume, Together With the Subjects on Which They Have Written, and the Pages on Which Their Contributions Appear*

PAGE

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*(Continued)*

PAGE

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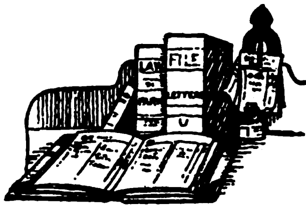
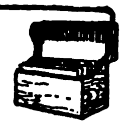
FARM KNOWLEDGE



# FARM KNOWLEDGE



## PART I

# The Business of Farming

IT has been said by one of America's greatest agricultural authorities and educators, that

> **The requirements of a good farmer are at least four: The ability to make a full and comfortable living from the land; to rear a family carefully and well; to be of good service to the community; to leave the farm more productive than it was when he took it.**

This is a far different understanding than that of the many people who think of farming as a simple, threefold method of accepting the bounty of Nature. Such people believe that all the farmer need do is to loosen the soil and sow seed, give the growing plants a little cultivation and protection, and gather in the harvest; or, in the case of livestock farming, they see only the young animal as an instance of the world's natural increase, a little feeding and care, and a final slaughtering, or securing of milk or other product. It is from such directions as this that we hear surprised voices asking why *anyone* of ordinary intelligence cannot soon succeed on the farm! It is possible, and indeed more than probable, that among farmers themselves there are a good many who, though realizing the lack of grounds for such a query, are, nevertheless almost as far from a clear-sighted, comprehensive view of the situation such as that just quoted.

It is the purpose of this volume to introduce and take up in some detail the factors, the surrounding conditions, and the basic principles upon which depends the possibility of a man's meeting the requirements as set down above. The subjects have been grouped under four main heads, the first two being closely and logically related; the others, though of equal importance, being less definitely associated with any particular phase of farming. The groups discuss respectively, the business of farming; the farm home, family and community; the elements of those sciences upon which farming is founded; and the agricultural conditions and opportunities in the various states of the Union. Their scope and purpose are discussed each in its individual introductory note.

The chapters in Part I are designed rather to stimulate thought, study, and the formulation of future plans, than to give actual directions for performing the several physical practices which, to some minds, constitute the whole farming enterprise. Thus, the problems of planning the system according to which the farm shall be run, and of keeping records of what has been and is to be done, are of immeasurable importance, even though they do not include, but only take note of, each day's labor. Thus, too, the question of what the farmer

can do with his money, what it means and where and how it is distributed among men, does not touch the problem of how to get that money from the land. The principles of marketing—one of the greatest stumblingblocks in the path of profitable farming—begin, in the main, where the raising of crops and animals stops. The relations between owner and tenant, employer and employee, proprietor and manager involve a few knotty points, but not enough to warrant the almost universal tendency to leave them undiscussed and but partially—if at all—understood. Each of these subjects is treated, therefore, with a view to supplying the sort of data and general information that is all too scarce. Another chapter deals with coöperation, the means by which, and the road along which, several farmers can work together for the benefit of all, collectively and singly. The relations between the farmer and the law—that is, its nature, its purpose, and its enforcement—are, like the subject of farm ownership, etc., just mentioned, all too often and too widely misunderstood or completely overlooked. Rural economics is an even more abstract subject, and one, to many minds, as unfamiliar as it is unattractive. Yet it represents and deals with farming as one of the world's industries in all its vital importance. No farmer can completely shut himself off from the outside world as in the past he may have chosen or been forced to do; as farming has come to have a wide and significant influence on national and world affairs, so it is affected by each of the other lines of effort or interest that play parts in the cycle of production, transportation, and consumption. Lastly, there is the neighborhood, the result of the inherent social instinct in men, whereby they are led to gather together for the betterment of themselves, their families, their business, and their environment. Though apparently apart from any possible phase of practical farming, this subject is of the greatest importance, since the success of each farm makes for a better neighborhood of which it is a part, while every advance of a neighborhood is reflected in each of the farms that compose it.

It is in these ways that the farmer becomes a factor in the life that extends beyond his immediate, local interests; and it is only by broadening himself to meet the responsibilities and requirements of this rôle that he makes the most of himself and of his opportunities.—EDITOR.

**THE FARMER'S CREED**

**I believe that soil likes to eat as well as its owner, and ought, therefore, to be liberally fed.**

**I believe in large crops which leave the land better than they found it—making the farmer and the farm both glad at once.**

**I believe in going to the bottom of things and, therefore, in deep plowing and enough of it. All the better with a subsoil plow.**

**I believe that every farm should own a good farmer.**

**I believe that the best fertilizer for any soil is a spirit of industry, enterprise, and intelligence. Without this, lime and gypsum, bones and green manure, marl and guano will be of little use.**

**I believe in good fences, good barns, good farmhouses, good stock, good orchards, and children enough to gather the fruit.**

**I believe in a clean kitchen, a neat wife in it, a spinning wheel, a clean cupboard, a clean dairy, and a clean conscience.**

**—Henry Ward Beecher**

FIG. 1. The right use, management, and remuneration of hired labor are three important features of businesslike farming.

## CHAPTER 1

# Farming in a Businesslike Way

*By* ANDREW BOSS, *Professor and Chief, Division of Agronomy and Farm Management of the Department of Agriculture of the University of Minnesota. He was born, and lived for 22 years, on a farm in southern Minnesota. During this time he received a common-school education, but from the time he was 15 he managed a 360-acre farm owned by his father. When 22 years old he entered the School of Agriculture of the University, where, after graduating, he became foreman, then assistant, and finally professor of agronomy. Since about 1903 he has had charge of the live-stock, farm crops, and farm management work; having also been made Vice-director of the State Experiment Station, he has been in contact with all its substations and experimental farms. During all the time that he has been engaged in the Department of Agriculture he has had charge of numerous farms and has kept up with modern methods of farm operations. Through the extension work in farm management he is constantly in touch with the farmers in Minnesota; moreover, the nature of the teaching developed by his institution has been instrumental in keeping him familiar with practical farm conditions.*—EDITOR.

**SYSTEM in business.** No large business can succeed unless it is systematically conducted. Great engineering feats are accomplished in railway and road building and in the construction of buildings and machinery. Large manufacturing establishments turn out vast quantities of products of various kinds that are uniform as to composition, quality, and usefulness. Large corporations transact vast amounts of business and amass huge fortunes from small margins of profit. Farmers and others often marvel at the success of these great organizations and wonder how it is attained. If the answer were reduced to one word, that word would be "system."

But a business cannot be systematically conducted without careful planning of its details and careful organization for efficient operation. An example will illustrate: The successful merchant in organizing his business first makes a study of the situation. He considers the needs of the community, the present and prospective demand for goods of certain kinds. He notes the supply and the cost of each article he is to handle, and inventories his resources. He calculates the cost for the labor that will be required to operate his business, and for equipment, taxes, insurance, and other items of expense he is obliged to meet. He regulates his purchases and his prices by the cost of securing his goods and of putting them on the market, and by the competition

he is likely to meet. If the business is a large one, it will be organized into departments. Each department will be put in charge of a responsible head. The labor and accounting charges will be so systematized and recorded as to show the profits and losses from each department and from the business as a whole. Systematic methods of accurate accounting, the knowledge of costs and of the expense of operating the business, enable him to eliminate from it all unprofitable lines and enterprises, and to show where the most efficient service is being given. Thus he weeds out of his business operations all needless steps and competition, and avoids needless waste of time and energy. Systematic organization of the business is the keynote to success.

**System in farming.** To succeed as well with the farm business as the best business man succeeds, requires that farming also be organized and systematized. In establishing a farm business, the farmer should make a study of the possibilities. He should consider the character of the soil and the climate, the demand that will be made upon the natural soil fertility by the crops grown, and the type of farming to which the locality is adapted. He should consider in connection with the draft on soil fertility the sources from which it may be renewed and at what cost. He must study the local markets, the transportation facilities, and the terminal markets, and the demand for such crops or livestock as he proposes to raise. He must consider the available labor for the operation of the farm business and the prospects for hiring additional labor. He must consider the cost of producing crops under these conditions and the probable net profit that can be gained from their production. In studying the problem, interest on investment, taxes, insurance, and other expenses must be included as they affect the final result. The labor of the farmer and of his family should be rated at a fair wage and included as a part of the cost of making the various crops or farm products.

In the operation of a large farm it is frequently necessary to organize in departments in much the same manner that a store business would be organized. This involves keeping accounts with the dairy, with the swine, with the grain crops, and other similar enterprises. Where the enterprise is large enough, it is well to put an expert in charge of each large branch or group of activities, thus enabling one to use cheaper labor in performing the work or to make the labor more effective by closer supervision. With farming so conducted, and where accounts are kept with the various lines of work, it is possible to make a business statement at the end of the year which will show which lines have been profitable and which have been unprofitable, and whether the farm business as a whole has paid a fair rate of interest. A business statement of this kind will show the weak spots in the farm organization, the poorly paying enterprises, and those which should be eliminated from the business in order to permit greater profits from the investment and operation.

**Three essential factors in successful farming.** Of the many factors that influence the profits from farming, the most essential ones are: (1) the planning of the farm business; (2) the execution of the plans; and (3) the recording of the farm transactions. The first two of these are treated in this chapter, the third in Chapter 2.

**The plan.** A well-balanced farm business cannot be developed unless much careful planning is done. Plans must be made that provide for economic buying and for successful selling of the farm products. The type of business, the size of business, and the use of capital and labor, must all be carefully fitted together if the best results are to be obtained. The use of lands, the cropping system, the kind and number of buildings, and the labor requirements, must all be adjusted if loss is to be avoided. The kinds and amount of livestock to be raised and the use to be made of crops and products that will be

grown for sale, must be planned for if a systematic business is to be built up. Hit-and-miss methods of farming do not make for a steady volume of business and will not permit the profitable employment of labor and equipment. A well-planned farmstead and correctly laid fields will avoid waste of labor and energy.

**The execution.** In the execution of the plans great skill is called for on the part of the farm manager. It is one thing to make plans and another to put them through. The management of labor is a very essential factor in securing profits from a farm. Investigation of the question indicates that it is the most important single factor in the farming business. The kind of labor that should be employed, the reward for labor, contracts with labor, and the assignment to duties, are essential parts of the farm business and must receive careful consideration and prompt execution if the best results are to be obtained. Marketing the product and buying supplies is also an important part of the farm business and calls for executive ability on the part of the farm manager. Too much attention cannot be given to a study of the needs of the farm business and to the prompt transaction of the daily tasks.

**The records.** It is impossible to understand the farm business or to know the profits, or gain made, or the losses incurred, without records of the important transactions. While the ordinary farm business does not call for extended bookkeeping, it does call for a few accurate records that show the essential facts relating to the farm business. With adequate records on which to base the knowledge of the farm, it becomes possible to eliminate promptly, or as circumstances will permit, the unprofitable enterprises, the non-paying cows, or the non-productive labor.

## Planning the Farm Business

In the organization of a farm business there are certain cardinal principles which must be observed. Capital, land, and labor are the primary factors in agricultural production. The adjustment and correlation of these factors in correct proportions is one of the most important parts of the farm business. This adjustment cannot be made without careful calculations and planning by the farmer. Production is limited by the factor which is deficient. If there is not sufficient capital available, it will be impossible to build up a big business or to equip the farm fully with livestock, machinery, and implements, or to employ sufficient labor to operate the machinery and to work the land well. If labor cannot be secured, there is again limited production because farm operations cannot be performed at the proper time and the farm equipment and land cannot be used to the best advantage. If land should be the deficient factor, capital invested in tools and equipment is wasted because they cannot be used to their full capacity; labor cannot be kept constantly employed at productive tasks, and there is consequently loss of profit. Most careful planning of the relation of these primary factors is therefore required.

### The Size of the Farm

The average-sized farm in the United States, according to the 1910 census, is 136 acres when measured by land area. When measured by capital value it is $6,444. Measured in terms of labor required for the farm, it is approximately a 1½-man job. It is safe to assume that these figures represent what is the best size of farm for conditions in the United States at the present time, because they reflect the combined judgment of all of the farmers in the country; yet this does not determine what is the best size of farm for any individual farmer. That must be determined by the circumstances surrounding the individual and the amount of capital he has to invest. Some types of farming demand much more

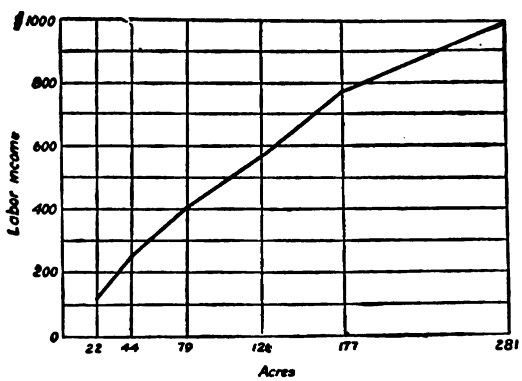



FIG. 2. Effect of size of farm (*indicated horizontally*) on income (*indicated vertically*.) Generally speaking, the larger the farm, the more money it makes. (N. Y. [Cornell] Bulletin 295.)

capital than others. The size of the farm must always be gauged by the kind of business to be done. It is important for most types of farming that there be a well-proportioned land area if the greatest profit is to be secured. It is impossible to build up a large diversified farm business on a farm of few acres, though a large truck, fruit, or other specialized farm business may not require a large acreage.

Agricultural surveys made in many different parts of the United States indicate clearly that the labor income of the farmer on the small farm is less than the labor income of the farmer on farms of medium or large size. There are definite economic reasons for this. On the small farm, devoted to the general crops of the locality and producing livestock products also, it is impossible to use either the machinery or the work stock to full capacity. The labor of the farmer and his family on a small farm is often unemployed or employed in unprofitable work throughout a large part of the year. A large proportion of the total products from the farm is required to supply the family, thus leaving but little to sell. A farm of 160 acres can be operated with only a little more machinery and equipment than one of 60 or 80 acres. As a consequence, a much larger acreage is handled for the money invested in equipment, and the cost of production is greatly reduced. Still larger farms offer the possibility of larger incomes through the more effective use of horse and man labor, and machinery. It has been frequently demonstrated that the medium-to large-sized farm can be the most economically equipped, the most efficiently operated, and that when properly managed it will return the largest income. Special types of farming, such as gardening, fruit raising, or poultry or bee keeping, may profitably be conducted on small land areas, and to them the above general statement will not apply. When land is cheap, it is wise to secure a large enough amount to permit the eventual development of a large business; but it is not wise to invest so large a part of the available capital in land as to prevent the proper equipment of the farm or to limit the employment of labor for tilling it. For a general type of mixed farming, 80 to 100 acres with a capital of from $5,000 to $6,000 is probably the minimum size which can be profitably operated. Only a few men are capable of getting maximum profits out of farms larger than 320 acres with a capital investment of $20,000 or more. A larger farm business may be profitable in special cases, but more than average managing ability is required to operate larger enterprises successfully. The best size of farm must be determined by the type of farming and the kind of business to be done.

FIG. 3. Corn on a test plat which has grown the same crop for several years in succession. Compare with Fig. 4, to see the effect of rotating crops.

## Type of Farming

The type of farming that may be successfully followed in a locality is determined primarily by the climate, soil, capital to invest, and the supply of labor. Transportation facilities, distance from market or shipping point, market demands, price of land, and the personal desires of the farmer are secondary considerations that must be carefully weighed if a well-balanced plan is to be made. The requirements for some of the more common types of farming are as follows:

**Vegetable gardening.** This type of farming must be intensive. It demands large amounts of labor and capital, but can be conducted on a limited area of land, which, however, must be highly cultivated. It should be located in the vicinity of a large city, near a terminal market, or in a particularly favorable locality. This type of farming requires 2 to 10 acres of rich, easily tilled land per family. It calls for industriousness and keen business ability, as the marketing problems are difficult and numerous, and demand good business judgment and prompt action. The profits from this type of farming may be large under favorable conditions. They are somewhat uncertain owing to market fluctuations, insect pests, and plant diseases.

A decided advantage in this type of farming is the quick returns from the capital invested. Many of the garden crops mature within 6 weeks or 2 months after planting. They are usually sold for cash and the money may be immediately reinvested. Gardening does not give profit-bearing employment throughout the year. Those who wish to make a large income in this business must capitalize highly and provide hotbeds and greenhouses so as to give employment to labor on profitable enterprises during the winter season. Vegetable gardening is not adapted to thinly settled sections, but follows best the development of large markets in large cities.

**Fruit growing.** Fruit growing, like vegetable gardening, is adapted to intensive farming and calls for high capitalization per acre. It also requires a large amount of labor when successfully followed. Fruit growing is adapted to somewhat larger land areas than truck gardening and is capable of extensive development. A farm family can well care for from 5 to 40 acres, depending upon the organization of the business, but sometimes much more land than this can be operated profitably when fruit growing is made the leading specialty. While this type of farming is often urged as particularly remunerative and easy, the opposite is usually the case. No type of farming calls for greater watchfulness and more attention to details. Destructive diseases must be kept out. Insect pests must be combated, and frequent spraying, pruning, and replanting are required in order to keep the fruit in bearing. If the best of care is given, it may be made a very profitable business, though the profits are often adversely affected by discouraging market fluctuations. Apple growing in some places pays a profit of from $50 to $150 per acre. Under very favorable conditions, it may be much more than this in favorable years. Other tree fruits pay correspondingly well, if given good care and if they are well marketed. It is a business for the specialist rather than for the general farmer. Fruit growing, like truck farming, is not particularly well adapted to a new country and is successful only on soils adapted to the fruits and in climates where they can succeed. Modern methods of transportation have to a large extent improved the facilities for marketing fruit, and the business is consequently expanding.

**Single-crop growing.** There are not many crops that can be grown continuously until the land is exhausted or becomes infested with disease, resulting in frequent losses. Cotton raising in the South, corn raising in some of the central states, and tobacco raising in some sections have been continuously practised for some years, resulting in seriously depleted soil and disastrous financial conditions. Single cropping requires much less equipment per acre than truck farming or fruit growing, and can be carried on in a more extensive way. In following a single-crop line of farming, it is usually necessary to resort to the use of fertilizers to keep up the production. Hay raising in the vicinity of large cities or markets is a common example of single-crop farming. This type of crop raising can be followed successfully longer than most kinds because of the freedom of grasses from disease and because the land kept in hay does not wash as badly as when cultivated for crop growing. It is safe to say, however, that no successful method of single-crop farming has been developed and except under unusual circumstances this type of farming should not be advised.

FIG. 4. Corn on a plat close to that shown in Fig. 3, but on which a five-year rotation is practised. (This and Fig. 3 from Minn. Bulletin 125.)

**Diversified farming.** Diversified farming is the most popular of any type and is more generally adapted to soil and climatic conditions in all parts of the United States. This type of farming properly includes both crop growing and livestock raising. The proper arrangement of crops in rotation aids in maintaining the fertility of the soil and helps the farmer to avoid competition between crops for labor. It also enables him to employ his help profitably throughout the year, since the large demand for labor by the livestock usually comes in the winter season when the demand for labor by crops is comparatively inactive. If the crops grown on the farm can be fed to livestock which is adapted to the locality and the market, quite as large profits can be made from the crops by marketing through the livestock as by selling them direct. The manure from the livestock, returned to the farm, will aid materially in keeping the soil in good physical condition and in maintaining the supply of chemical elements which are necessary in producing succeeding crops. The income from a diversified farm, because of the varying interests and sources of receipts, is much larger than from a farm where a single-crop system is followed. This type of farming is adapted to either large or small farms. The size of the business is often determined by the amount of labor available. Diversification allows a variation in the crops to be grown from year to year, and permits the production of livestock suited to the demands of the market. While it does not pay so large a margin of profit per acre as some of the intensive types, in favorable years, crop returns from the diversified farm are much more certain. The larger number of acres that can be handled

also enables the farmer on a diversified farm to earn a larger labor income than a man on the smaller farm who gets larger returns per acre. The average farm family on a diversified farm can supply all the labor for and can care for the products from 80 to 160 acres of land. When the farm is well planned and organized, and the crops and livestock are properly proportioned, it is easily possible for the average farm family to handle the crops and products from 240 acres or more. Gross returns from farms so handled should, with normal prices for products, be from $20 to $40 per acre, depending on the skill of the manager and the quality of the soil.

**Livestock raising.** Livestock raising has come to be looked upon as the highest type of general farming possible. In certain sections it has been made the main line of production. Livestock farming may include the production of beef cattle, sheep, hogs, dairy cattle, horses, and poultry. Some farmers will produce only one class of livestock, others will be so situated as to make it possible to produce profitably two or more kinds. The smaller animals are adapted to the smaller farms, and call for comparatively small capitalization. The larger animals, such as horses and cattle, are best adapted to large farms where grazing land is cheap and plentiful, and generally the animals can be handled in large groups. Stock raising of this kind calls for large investments in buildings and breeding stock. It requires also a great deal of labor and carries large risks. This field, particularly, calls for skilled management, good judgment, and business ability on the part of the farmer. Buying, finishing, and selling stock is quite as much a part of the business as the production of crops. Unless the animals are well matured and sold to advantage, there is likelihood of large loss. Where good management can be given, however, livestock raising is one of the most remunerative types of farming and provides an almost certain income. Dairying, especially, is expected to bring a sure income, when conducted in the vicinity of good markets.

## Distribution of Capital

The money invested is a large factor in earning an income from the farm. Few farmers think of this, but it is a fact nevertheless. Bankers recognize the earning power of money when they pay 4 per cent interest on savings deposits and loan these same deposits on farm lands at 6 or 8 per cent. Business men are careful to invest their money where it will not only yield interest, but where it can be turned over quickly, thus early yielding profits. Farmers must study this question and so invest their money in the farm business as to earn the quickest and largest returns.

Farm capital may be divided into two classes: (1) permanently invested or "fixed capital"; and (2) temporarily invested or "operating capital." The first class is represented by the investment in land and improvements such as buildings, fences, wells, drainage, etc. The second class includes money invested in teams and other livestock, seeds, feeds and supplies, and cash for running the business. Farm management investigations have clearly shown that a relatively large proportion of the total capital should be used as operating capital. These studies show that the farmers who reserve sufficient capital to employ help when it can be used profitably, or to buy stock for feeding purposes when there is promise for profit, or for some specific enterprise when conditions are favorable, receive greater returns from their farms than do those who invest too large a part of their capital in the fixed form, such as land and buildings. Studies in Wisconsin show that certain farmers, who had 86.5 per cent of their capital invested in the fixed form and only 13.5 per cent in operating capital, received a labor income of only $168. Certain other farmers, who had only 71.8 per cent of their capital in fixed form, and 28.2 per cent

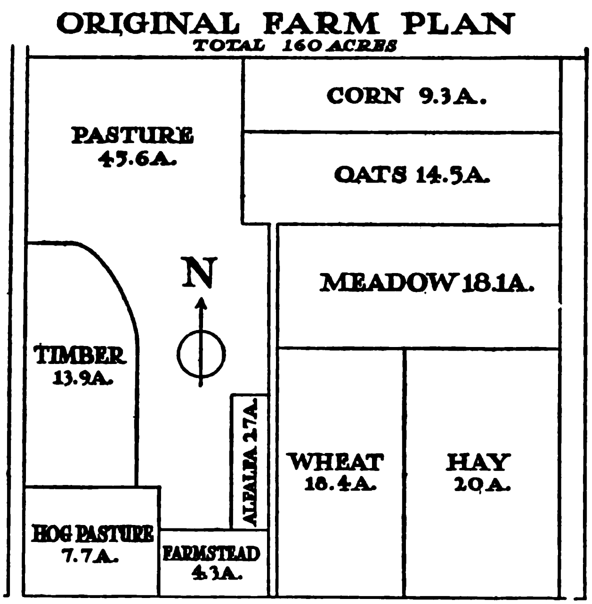



FIG. 5. Outline map of farm as originally operated. Note irregular shapes and unequal sizes of the fields. Compare Fig. 6

in operating capital, received a labor income of $1,629. Other studies made in various parts of the United States support this statement and indicate the wisdom of a generous investment in operating capital. Just what this proportion should be will depend upon the type of farming and the circumstances of the individual. For the average diversified farm, approximately the following proportions should give satisfactory results:

| | | |
|---|---|---|
| Fixed capital | Land | 45 per cent |
| | Buildings | 20 " " |
| Operating capital | Livestock | 22 per cent |
| | Implements and tools | 8 " " |
| | Cash for operating | 5 " " |

It should be borne in mind that in buying a farm and equipping it with new machinery, the proportion in the land investment will run lower than indicated, while the values in implements and tools will be higher. The machinery, however, depreciates in value, with use, while land is likely to increase in value as it is developed and put under tillage. In the older communities the proportion of the investment will change greatly. On small farms near terminal markets, the machinery investment may become comparatively insignificant and the proportions will vary decidedly with the increase or decrease of livestock.

### Disposition of Products

In planning the farm business the whole problem of what to produce and how to sell it should be thoroughly worked out. Changes will be necessary as agricultural developments and new economic conditions arise, but the general plan of disposing of the product can be laid. Such matters must be considered as the kind of product that will be in demand, the amount that can be produced, storage and preparation for market, the kind of package in which it can best be delivered, the transportation facilities and charges, the condition of goods on arrival and the distribution system through which they must go to the consumer, the commissions to be paid, and the total expense that must be met. These questions all affect the profits to be made and determine whether or not it is wise to undertake certain lines of production. These questions can all be thought out in advance, if attention is given to them. They are a part of the business plans of every successful farmer.

**The labor supply.** It is impossible to build up a farm business without giving consideration to the question of labor. Large quantities of man-and-horse or motive-power labor are required if a big farm is to be operated. Investigations show that in general farming at least one man is needed for every 100 acres of land, and that one horse, or the equivalent in motive power, is needed for every 30 acres. More intensive crops demand more labor than this. It would be very unwise for a farmer to try to operate 500 or 600 acres of land, if his crew were limited to 2 men and 8 horses. The requirement of the farm for both man and horse labor should be conservatively calculated in planning the farm organization, and estimates made of the possibility of hiring or otherwise supplying the amount needed. If it cannot be provided, the plan must be modified to meet the possibilities of the case. More will be said on this subject under "Labor requirements" (p. 16).

## Planning the Farm Layout

A well-planned farm is a source of constant satisfaction. It may also be a source of increased profits. An outline map of the entire farm, showing the location of the farmstead, the size and shape of the fields, and indicating the rotations to be followed and the crops to be raised, can readily be made (Fig. 5, and Fig. 336 in Vol. III.) A map of this kind makes it easy to record the yield of crops from the various fields and the operations on each. It can also be used for recording the application of manure and such other facts about the farm operations as may be desired.

The working out of a map of this kind helps the farmer to see and correct the weak spots in his plans for cropping and operating the farm and, when well done, leads to more uniform production and a more steady volume of business. Frequently it will be necessary to work out a temporary plan which can be modified or changed from year to year until the permanent plan can be followed. The completed plan is shown in Figure 6.

When the permanent plan is finally perfected, several outline copies should be made, so that they may be used as wanted. One can be used for a yearly crop ledger plan, as shown in Figure 7; another, as a record of manuring, as shown in Figure 8.

## The Farmstead

**Planning the farmstead.** The operations of the farm are directed from the farmstead. It is the most important place on the farm. For this reason it should receive careful attention in laying out the general plans. The location of the farmstead is important from several points of view. In the first place it is to be the home of the family and must be pleasantly situated. Preferably it should be on relatively high ground where a good view can be obtained of the landscape and farm, and where it is not too far from the main roads of local travel. For convenience in getting crops to and from the fields, it should be located as centrally as possible without violating the first principle mentioned. Many trips are made from the farmstead to the fields, and if, located at one end of the farm or at a corner, it may mean very much unnecessary travel in getting crops in from the field and getting manure back to them. The arrangement of fields, lanes and fences, may also greatly influence the distance to be traveled in doing farm work (See Fig. 9). It is important that the farmstead be well drained. Locating it on high land with a good slope in all directions gives the best drainage. Sometimes artificial drainage is necessary, if the farmstead is located on low ground. Muddy yards and stagnant ponds are decidedly objectionable in the farmstead. They are disagreeable to work in and around, and may be the source of malignant diseases. It would be better to incur extra travel in handling the crops than to locate the farmstead in an unsanitary spot.

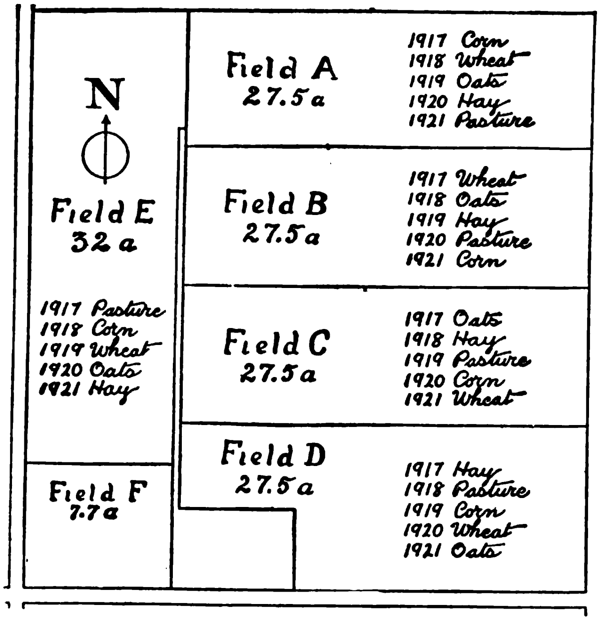



FIG. 6. Map of farm shown in Fig. 5 after being rearranged, giving size of each field and the proposed rotations. Field E should be divided into several smaller plots to provide for hog and calf pasture as well as special crops such as potatoes or seed corn.

**Size of farmstead.** The size and shape of the farmstead will be determined by the type of farming to be followed. There is a temptation in the development of many farms to make the farmstead too small. It should be large enough to contain all of the farm buildings and to give protection to them through the planting of windbreaks when such are not naturally provided. A farm that is devoted to grain growing or single crop raising, may need but few buildings. If but little livestock is raised, paddocks and yards need not occupy much space. A fruit farm or vegetable farm located on high-priced land near large cities should occupy but little land for the farmstead. Possibly one or two acres would be sufficient for the purpose. On a grain farm, two or three acres may be sufficient. On the average diversified farm of about 160 acres, 4 to 6 acres is not too much to use as a farmstead. Larger farms and those on which livestock raising is followed extensively may require as much as 10 acres for the proper arrangement of the buildings and paddocks. While it is desirable to have a farmstead of adequate size, no land should be wasted. Every bit of the land should be put to good use. No vacant spots should be left to grow up to weeds. Lanes, paddocks, and courts should be kept clean and tidy. This can often be done by pasturing down frequently with sheep or other light animals. Even the lawn and dooryard can often be pastured down to good advantage. The shape of the farmstead is often determined by the lay of the ground and by natural surroundings. Groves, lakes, or other natural formations may be the deciding factor. When space and the lay of ground will permit, a rectangular outline is best on most farms. Curved drives and walks may be laid out on the inside of the farmstead to give beauty and attractiveness to the place, but the general outlines will be on the rectangular order. A desirable farmstead is shown in Figure 10.

**Location of buildings.** The location of the buildings on the farmstead is an important matter. The work in certain buildings is more or less related, and it is a wise plan to group together buildings which call for work of the same kind, thus obviating needless

travel across the farmstead. As an illustration of this point, it may be mentioned that a farmer seldom goes from the horsebarn to the field without taking a piece of machinery with him. To get the machinery, he must visit the machine shed, if the machinery is properly housed, as it should be. Economy of time, therefore, will demand that the machine shed be placed near the horsebarn and the fields. Similarly the feed supply is most commonly used in connection with the production of livestock. For that reason the granary or storehouse should be located near the barn or it should be made a part of the barn itself. When grain is threshed or purchased, it may then be placed in the storage rooms, and need not be moved again until wanted as feed for livestock.

The corn crop in the corn-growing states is fed largely to hogs and to fattening cattle. It is essential, therefore, that the corncrib be located near the feeding yards, so that it can be taken directly from the cribs to the feeding floor or the feeding bunks. When only a small amount of corn is fed, this may not be an important matter, but when large numbers of animals are raised it may be the means of saving large amounts of time. The unnecessary travel caused by poorly placed buildings is illustrated in Figure 11. In the placement of buildings on the farmstead, the farmhouse should receive first consideration. It should be placed at least 75 to 150 feet from the main road, so as to avoid the annoyance of dust and too much noise from passing travel. It should be situated 100 feet or more from any of the barns, and protected as much as possible from objectionable views and odors. The other buildings can be placed in the order of their importance and with the view of making use of any natural advantages that the location may give.

Inside plans of buildings. The floor plans and inside arrangements of the buildings should receive close study. Convenience in doing chores is a great factor in saving labor. Lines of stalls should be arranged to permit the most rapid work in caring for the animals. Access to feed supplies should be convenient. Feed storage rooms and bedding supplies should be where they can be easily reached. Arrangements for watering the stock, either in the barn or in tanks close by, should be provided. It is surprising how much time can be saved in doing chores in a well-planned barn.

Yards and paddocks. Sufficient yards, paddocks, and small pastures should be provided where livestock is raised, to provide for outdoor exercise and grass as needed. It is wise to change paddocks frequently. Therefore, one or two extra ones can well be included. The yards and paddocks should be close to the barn, with suitable permanently fenced lanes closed by strong gates so as to prevent the livestock getting out. The small pastures may be farther away, but should be included inside of the windbreak, so as to get protection from cold winds, and also that they may be more constantly under the eye of the caretaker. It is well to plan the farmstead large enough so that it can be expanded without destroying the windbreak or replanting. Even though the farmstead is not all used to begin with, a developing farm business may rapidly grow to it.

### The Field Plans

Well-planned fields may be as great an assistance in saving labor in doing the farm work as a well-planned farmstead is in doing the chores. There are a few vital principles which should be followed in laying out the fields. It is economy to so arrange the fields as to lead directly toward the farmstead. This arrangement does away with loss of time in getting to and from the fields, and is an important factor in securing an equal distribution of manure over the entire farm. Short roads well made should be the rule.

Size of fields. The size of the

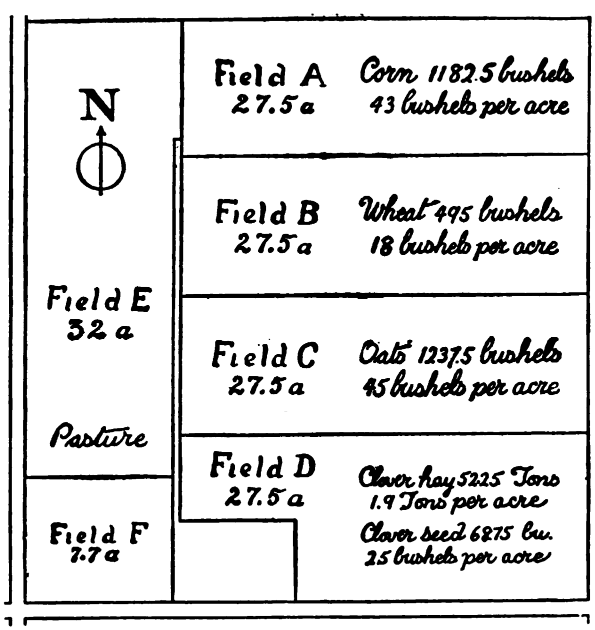



FIG. 7. Same map as shown in Fig. 6, used for recording the crop production of each field. Such a record for each year can be bound or pasted into a book to supply a permanent history of the farm. Dates of plowing, planting, etc., can be added, if desired.

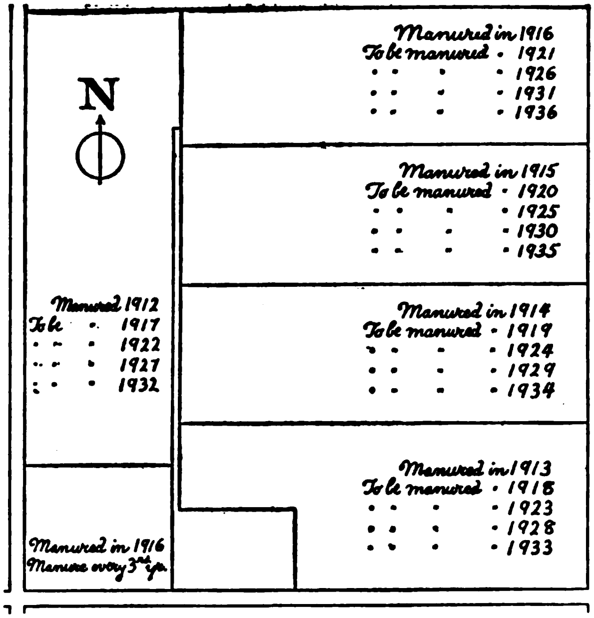



FIG. 8. The map can be used to keep track of the manuring system. An even distribution of manure is desirable, and, unless one keeps track, certain fields are likely to be overtreated at the expense of others.

fields is an important factor in planning the farm. So far as possible they should be uniform as regards both size and the quality of land. Uniformity in size leads toward making the farm business systematic. Evenness in character of soil permits working the whole field at one time. Fields of even size also enable the farmer to provide a definite acreage of each crop each year, and permit him to regulate more easily the amount of livestock to be kept, thus insuring a constant supply of food for the stock and a steadier volume of business than where the fields are irregular in size. This results in more uniform income to the operator. So far as possible, the fields should be of good size. They must be suited to the rotation that is to be followed. It is understood of course, that it is not possible to change the size or the shape of fields materially on many farms because of the topography of the land. Creeks, rivers, sloughs, or stony ridges may be factors which determine the shape of the fields. These matters must all be studied carefully and the plan followed which gives the balance of advantages.

**Shape of fields.** So far as economy of teams and machinery is concerned, long, narrow fields are better than short or square ones. Opposed to this principle, however, must be set the expense of fencing. Square pieces of land are much more economically fenced than long ones. If the combination of livestock raising and grain growing is followed, a compromise must be reached between these two opposing factors. As a rule, the rectangular field about twice as long as it is wide, is best when both of these factors are considered.

**Rotation plans.** It is no longer considered safe to crop land continually to the same crop. Such a practice is almost sure to lead to various kinds of plant diseases and to result in loss of crop. A rotation of crops is best under most circumstances. The adoption of a crop rotation and the division of the farm into fields of regular size tend to decrease the number of failures rather than to increase them, and helps to systematize and make uniform the business of the farm. The plan of rotation to be followed depends altogether upon location, the type of farming, and the amount of livestock to be kept. No matter what rotation may be followed, it must be built around the principle of a change of crop in systematic order. A true rotation provides for a succession of crops of different kinds. For ordinary purposes, crops may be classified as (1) grain crops, (2) grass crops, and (3) cultivated crops. A successful rotation will have a proper combination of these 3 classes. There must be a field for each year in the rotation followed, or changes in crops cannot well be made. A good three-year rotation would call for the division of the farm in three equal-sized fields, with one year devoted to grain, a succeeding year to grass or clovers, and the third year to cultivated crops. Whether such a rotation can be strictly followed or not depends upon the kind of business done. In some localities, one third of the farm should not be in cultivated crops. In others, grain raising will not warrant one-third of the farm to be devoted to that crop. In that case there are two alternatives. Either one field may be divided and some other crop put in temporarily, or the farm may be redivided into smaller fields and a longer rotation term adopted. A 5-year rotation, for instance, would call for the division of the farm into 5 fields of correspondingly smaller size. A suitable rotation for that kind of a farm in the corn-growing districts would be: first year, grain; second year, timothy and clover hay; third year, pasture; fourth year, corn; and fifth year, corn. This is not a perfect rotation, in that it calls for the same crop for 2 succeeding years. There is no harm, however, in raising hay or grass 2 years on land; and corn can be safely grown 2 years in succession where the land has been proper-

ly manured and cultivated. The essential thing is to plan the fields and adopt the rotation that will meet the needs of the farm business. The kinds of crops that will be grown and the quantity in which each will be grown will depend very largely upon the kind of livestock raised, the demand for feed, and the possibilities of selling on the market for cash. Good crop rotations are shown in Figures 12 and 13.

**Plans for maintenance of fertility.** The productive capacity of the soil determines largely the profits that can be made from farming. Unless the soil fertility is maintained, it will yield but poorly, often not paying for the labor put upon it. The scheme of cropping adopted should provide for the maintenance of fertility and should induce large production. It has been shown that production cannot be maintained without incorporating in the soil a good supply of vegetable matter. This vegetable matter may be supplied either by plowing under green crops or by the application of barnyard manures. In the best systems of farming, both expedients are resorted to. Clover, cowpeas, alfalfa, and other legumes are especially useful in maintaining soil fertility. These crops gather nitrogen from the air and incorporate it in their own structure. When these crops are plowed under and allowed to decay in the soil, they thus add large quantities of nitrogen to the soil. Phosphorus, which is another element of fertility most likely to be depleted, can be supplied only through the addition of barnyard manure or by the application of the commercial forms of phosphate. All of the necessary elements of fertility can be supplied to the soil in liberal applications of barnyard manure. It is for this reason that livestock raising on high-priced land and in thickly settled localities is so popular. Fertility can best be maintained by liberal applications of barnyard manure and by the use of legume crops for green manuring. Corn stalks, grain stubble, and most other crop residues may often be plowed under to advantage. While not so rich as the legumes, they possess considerable fertilizing material and help in keeping the soil in good physical condition. For certain crop conditions, acid phosphate, rock phosphate, potash and other forms of commercial fertilizers can be used with profit. The best results will usually follow their use in conjunction with the farm manures.

## Livestock Plans

Large quantities of cheap rough feeds for which there is no market are grown on most farms. These feeds cannot be transported to market profitably on account of their bulk. Straw from the various grains, corn fodder and silage, and the aftermath from the meadows are examples of this class of foodstuffs. Many farms contain rough land which is difficult to till. Such land will often grow good grass and make good pasture. It can be made to return cash to the farm through the use of livestock. Pasture, even on comparatively expensive land, is one of the cheapest animal feeds that can be provided. Investigations show that the greatest profits from livestock are made where animals are raised on these cheap feeds. Expensive grain feeds may profitably be fed to livestock at the finishing period or for special production, but experience has shown that it is not profitable to raise livestock for market purposes on highly concentrated marketable grains.

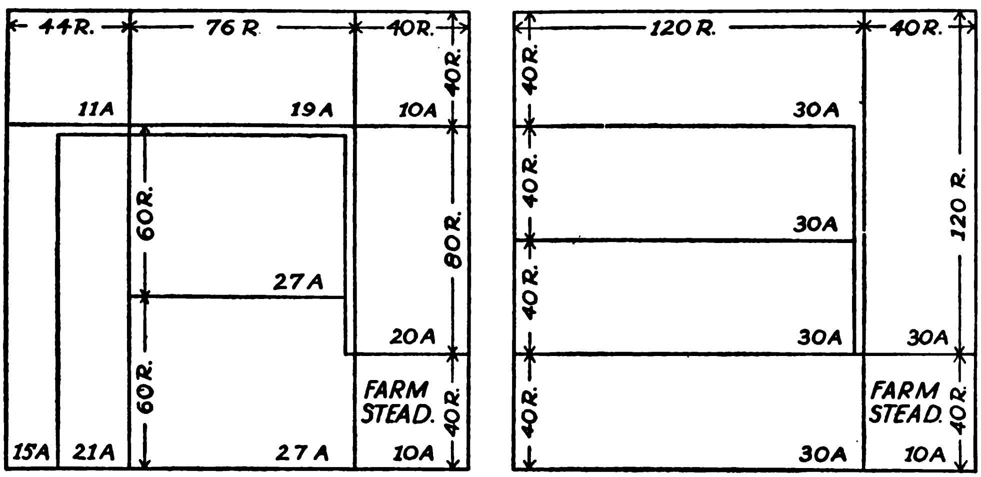



FIG. 9. A poorly planned farm (*left*) and a well-planned one (*right*). In the first the average distance from farmstead to fields is about 70 rods; in the second, 24 rods. On this basis it will take a man and team 4 days more to grow a 30-acre field of corn on the poorly arranged farm than on the other.

The kind of livestock to keep, therefore, and the amount of livestock are determined largely by the amount of pasture land available and by the amount of coarse roughage grown that cannot be disposed of except through the medium of livestock. Necessarily, the kind and amount of stock that can be kept will vary with the sections of the country in which the farm is located. For average conditions under which general farming is followed, however, it is believed that there should be one cow kept or the equivalent of other livestock, to each 4 or 5 acres of land. Under such conditions the animals can be maintained largely on the cheap feeds of the farm, and will in return provide manure enough if carefully husbanded to maintain permanently the fertility of the land. On very productive soil and under intensive systems of agriculture, it may be found profitable to have as much as one cow, or the equivalent, to each two acres of land. Under range conditions, not more than one such animal to each 10 acres of land may be advisable. No fixed rule can be laid down that all can follow, but farmers are urged to study conditions which prevail in their locality and to observe the principles laid down.

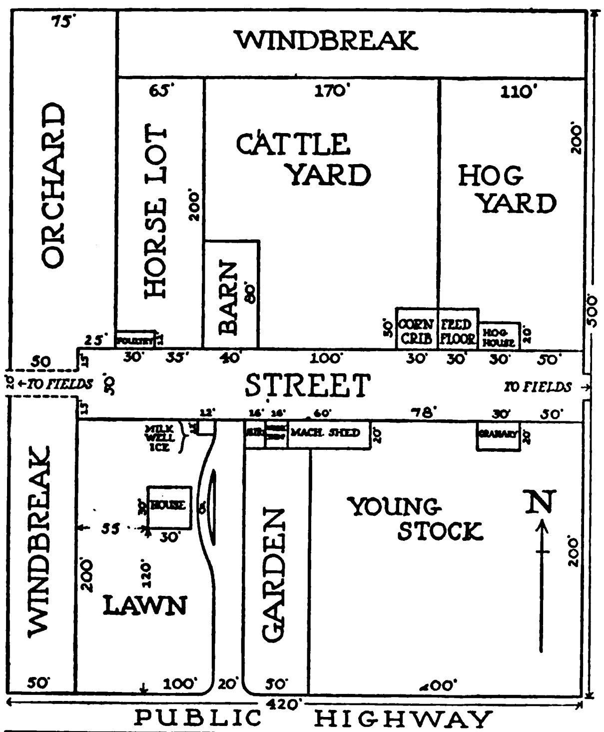



FIG. 10. A well-planned farmstead. Note location of machine shed near barn and on direct line of travel to field; that of workshop and combined milkhouse and icehouse between house and barn; that of the kitchen garden near the dwelling; and the close, convenient grouping of all the buildings.

Shelter. Shelter for livestock is necessary in almost all localities. The quantity of shelter, however, varies with the climate and with the kind of stock to be raised. The smaller the investment in shelter, of course, the less expense or cost of production. The plan of the farm, however, will not be complete without providing adequate shelter for the class of stock that is to be raised. Sheep and beef cattle do quite as well in open sheds with only sufficient protection from cold rains and snow. Dairy cows must be more carefully housed if they are to give the largest production. Plans should be made, not only for winter protection, but also for protection against flies, ticks and other pests. Dipping vats are an essential part of the equipment in the South.

Feed Supplies. If much livestock is kept, the farm manager must look well ahead and make sure that he has sufficient feed supplies in sight to meet the demands. Profits from livestock raising are quickly consumed through the purchase of feeds. It is often better to depress the amount of livestock grown in feed shortages than to overstock and have to purchase large quantities of high-priced feeds. In order to determine the feed needs of the year it is necessary to decide on rations that will be fed and to calculate the amount required of each class of feeds. This can quite as well be done a year in advance as to wait until the feed is needed, and often will indicate to the farmer what feeds must be bought. By knowing beforehand he can take advantage of market depressions and buy when they are low or sell his surplus when high. Likewise, complete plans for the care and management of the stock are essential. A knowledge of the available labor plans for feeding, and method of management, is of great use in avoiding loss.

## Planning the Labor Requirements

A successful year's business cannot be planned out without taking into consideration the labor requirements of the farm. It is a difficult thing to

know just when a man is doing a full day's work. A study of possibilities is worth while. Investigations show that normally about 3,000 hours of labor may be expected from a man in the year. This means the equivalent of 10 hours per day for 300 working days. This is somewhat less than farmers generally believe they should expect from farm labor; but it is based upon records of what has actually been done on a large number of farms covering a period of 12 to 15 years, and is approximately what may be expected. When a farmer knows, for instance, that he can expect 3,000 hours of labor per year, or 250 hours per month, he can make calculations on how many men to hire, provided he knows what would be required in the production of crops and in caring for livestock. These figures have been determined for Minnesota, and can likewise be determined or closely estimated for other localities. The accompanying table shows the labor requirements for producing field crops in Minnesota from 1902 to 1912.

TABLE I—AVERAGE ANNUAL HOURS OF LABOR PER ACRE REQUIRED IN PRODUCING FIELD CROPS, 1902-1912

| Crop | Average Hours Per Acre | |
|---|---|---|
| | *Man* | *Horse* |
| Wheat, shock-threshed | 12.3 | 29.9 |
| Oats, shock-threshed | 13.5 | 28.9 |
| Barley, shock-threshed | 12.8 | 29.9 |
| Fall rye, shock-threshed | 10.3 | 27.2 |
| Flax, stack-threshed | 13.7 | 33.8 |
| Corn, husked | 26.2 | 54.2 |
| Fodder corn, cut, shocked, and stacked | 30.4 | 52.6 |
| Ensilage | 32.6 | 59.8 |
| Potatoes, machine production | 44.4 | 75.0 |
| Mangels | 180.7 | 99.3 |
| Hay, timothy and clover, first crop | 12.3 | 13.0 |
| Hay, timothy and clover, two cuttings | 20.7 | 21.5 |
| Hay, wild | 12.2 | 16.9 |
| Timothy, cut for seed | 5.1 | 7.1 |
| Clover, cut for seed | 9.2 | 12.3 |
| Hay, millet | 17.3 | 39.1 |
| Hemp | 14.3 | 27.4 |

The labor that will be required in caring for the livestock has likewise been determined for Minnesota, and is shown in Table II.

TABLE II—TOTAL HOURS REQUIRED ANNUALLY PER HEAD OF LIVESTOCK

| Kind of Stock | Average | Hours |
|---|---|---|
| | *Man* | *Horse* |
| Horses | 83.7 | 9.6 |
| Cows | 148.0 | 31.8 |
| Miscellaneous cattle | 11.1 | .... |
| Hogs | 12.1 | 2.6 |
| Sheep | 2.9 | 0.6 |
| Fowls (100) | 141.2 | 9.6 |

Under similar conditions it is believed that these figures will hold in other states. Where conditions differ, a close estimate of the amount of labor per animal that will be required is about the best that can be done. With the requirements for crop and livestock labor known, it is possible to estimate how much labor must be supplied in order to carry on the business for the year. The use of this knowledge is illustrated in the following example:

ANNUAL LABOR REQUIREMENTS FOR A 160-ACRE WELL-STOCKED DIVERSIFIED FARM

Farmstead, 5 acres; permanent pasture, 40 acres; woodlot pasture, 10 acres; roads and waste land, 5 acres; crops, and labor in hours required annually.

| | *Man Labor* | *Horse Labor* |
|---|---|---|
| Oats......25 acres | 25 x 13.5 = 337.5 | 25 x 28.9 = 722.5 |
| Hay (2 cuttings)...25 acres | 25 x 20.7 = 517.5 | 25 x 21.5 = 537.5 |
| Corn for ears....25 acres | 25 x 26.2 = 655.0 | 25 x 54.2 = 1355.0 |
| Ensilage corn....15 acres | 15 x 32.6 = 489.0 | 15 x 59.8 = 897.0 |
| Potatoes..10 acres | 10 x 44.4 = 444.0 | 10 x 75.0 = 750 |
| Total for crop production... | 2,443 | 4,262 |

Livestock, and labor required annually to care for it.

| | *Man Labor* | *Horse Labor* |
|---|---|---|
| Horses......... 6 | 6 x 83.7 = 502.2 | 6 x 9.6 = 57.6 |
| Dairy cows....15 | 15 x 148. = 2220. | 15 x 31.8 = 477. |
| Young cattle...24 | 24 x 11.1 = 266.4 | ................ |
| Hogs..........30 | 30 x 12.1 = 363.0 | 30 x 2.6 = 78.0 |
| Sheep.........40 | 40 x 2.9 = 116.0 | 40 x 0.6 = 24.0 |
| Total for livestock........ | 3467.6 | 636.6 |

| | | |
|---|---|---|
| Total crop and stock labor.......... | 5,910.6 | 4,898.6 |
| Add for maintenance or nonproductive labor, 22% or............... | 1,522.3 | 1,099.6 |
| Total all labor................. | 7,432.9 | 5,998.2 |

If one man can be expected to perform 3,000 hours of labor per year, as previously stated, then it will require 2.8 men to perform the man labor on this farm. This would mean 2 men throughout the year and an additional man for 10 months. Or 2 men and a well-grown boy employed for the full year could care for the work. It has been calculated that a work horse can be expected to perform about 4 hours' work per day on such a farm. At that rate a horse would perform a total of 1,200 hours in 300 working days.

There would be required, therefore, to do the work properly, 5 horses. If much pleasure driving is indulged in or colts are raised, 6 should be kept.

The addition of 22 per cent to the productive labor is based on investigations which show that that amount of maintenance labor must be allowed for, to cover the total requirements for labor throughout the year.

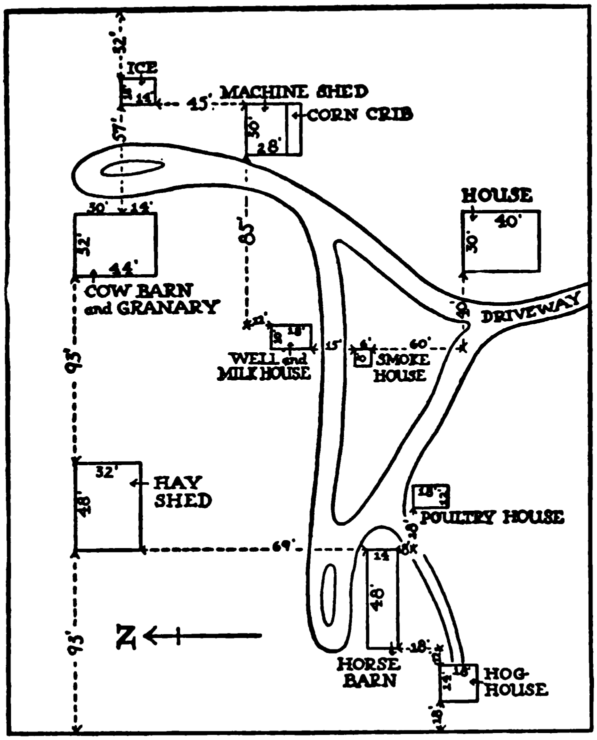



Fig. 11. A poorly arranged farmstead in which none of the buildings are placed so as to make their use fit in with that of others or with the daily trips about the barnyard. It can be shown that a rearrangement could save a whole month's time of a man each year in doing chores alone.

## The Execution of the Plans

No matter how carefully thought out the plans for organization and operation may be, success cannot follow unless the one in charge of the farm is a good manager. This means that he must have executive ability, tact, and good business judgment. In the execution of the plans, he will be chiefly concerned with the direction of the labor of men and horses, in caring for the crops and livestock, with buying supplies and selling the products of the farm. On a large farm he may be fully employed in directing the labor and transacting the business. On a small or medium-sized farm he may, in addition, perform a considerable amount of the farm labor himself. His efficiency in directing the labor and in keeping it employed on productive enterprises, is one of the important determining factors in securing success.

### Management of Labor

**Kinds of labor.** The management of farm labor may or may not be a serious task. A farmer on the average-sized farm in the United States pays out only $102 per year for hired help, according to the last census. This indicates that the larger part of the farm labor is performed by the farmer and his family. Family labor is usually very satisfactory for the reason that a personal interest is taken in the work. The management of this labor is much easier, as a rule, than the management of hired labor.

**Hired labor.** Where the demand for labor is greater than the farm family can supply, hired labor must be employed. This may be needed only for short periods during rush seasons when day labor may be employed. It may be needed for longer periods when the best results are obtained from hiring by the month or by the year. As a rule, the best help can be found for the longer period and steady employment. Day help usually costs more for the time employed than does help that is hired by the month or by the year, and is seldom as satisfactory.

A farmer's son who has grown up in the business is usually a very desirable farmhand. A man of this kind may often be found in the neighborhood, but ordinarily it will be best to hire one from a short distance away. If raised in the neighborhood, he is likely to have his work more frequently interrupted by calls from acquaintances and by a desire to take part in the social affairs of the neighborhood. If service only is required, one from a distant neighborhood will be most satisfactory. Sometimes a man can be had who has been for many years employed at farm labor, but

who has never been able to make a success in farming himself because he cannot plan work. Such men, when wisely directed and not required to do too much thinking, may give very satisfactory service. In some sections only transients can be had. In other sections, negroes, Mexicans, Chinese, or other cheap labor is the only kind available. Where such conditions are met, the labor must be closely supervised by the farmer himself or by a competent foreman who is constantly with the men. Even under such circumstances, transient or cheap help is rarely satisfactory.

The custom is growing in many places of providing small houses for laborers and giving them employment throughout the year. Young married men without capital are attracted by such opportunities. Older men with families, but without capital, may often be employed. This sometimes makes it possible for the farmer's wife to secure help in the house, as grown daughters may be able to help in emergencies. If arrangements can be made with such a family to board an additional man or two, it may relieve the farmer's family entirely from the necessity of caring for the hired help. To permit the employment of such help profitably, the farm must be large enough and the business intensive enough to employ the help on productive labor the year through.

## Reward for Labor

Wages. On farms, as in other places, laborers must receive a reasonable reward for industry, or they will not remain satisfied nor give their best service. The most satisfactory reward for labor is a good cash wage. Compared with wages in other callings, farm wages have been low; and yet most farmers complain of wages being too high and good help being hard to get. The wage of farm labor in the North, including cost of board, has been 14 to 18 cents per hour during the past few years. This is lower than laborers in other lines of work have been getting, and has resulted in much of the best help going into other vocations. Higher wages can be paid by the farmers if they give attention to keeping the labor actively employed on profitable enterprises.

Rate work. Payment by rate or piece work has been tried to some extent, but does not seem to be a satisfactory basis of reward except for certain kinds of work. Cotton picked by the bale, corn husked by the bushel, or potatoes dug by the bushel, are examples of the kind of labor that can well be paid for on this basis. For most farm work, however, the hired labor must be used together with family labor, and can best be paid for in cash on the day, month, or year basis. Where men with families are employed, the cash wage may often to good advantage be supplemented by certain privileges, such as free living quarters, a small garden, or the use of a driving horse at certain times. These cost the farmer but little, and are quite important in keeping the help family satisfied and contented to stay. Good living quarters, good board, and fair treatment must be given any kind of help, if the help is expected to give loyal and efficient service.

If members of the farmer's own family assist with the farm work, they also should receive suitable reward. This does not mean always that they should be paid in cash. Where a son of 16 or 18 years is doing a man's work, however, his good will and interest can often be held by giving him a share in some enterprise, —a half interest in the hogs or in one of the crops, not only while they are growing, but on market day, will go far to arouse a feeling of responsibility. A share in the poultry or butter will often influence the girls of the family to help with the housework rather than to become waitresses in the village hotel. Such treatment will do much to keep the young people at home and on the farm.

## Contracts for Labor

In hiring labor of any kind it is best to make definite terms as to the wages to be

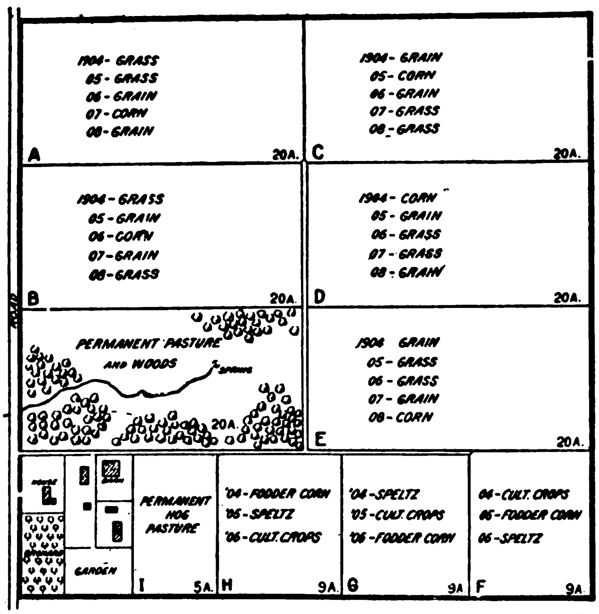



FIG. 12. A suggested rotation plan for a 160-acre diversified farm; involving a 5-course system on five 20-acre fields, and a 3-course system on three 9-acre fields. This leaves a 5-acre permanent hog pasture and a 20-acre permanent, watered stock pasture which can be supplemented by the aftermath in the grain fields.

paid, the work to be done, and the arrangements for board or living quarters. For long-term employment, the terms should be reduced to writing and each party to the contract should be supplied with a copy for reference. Witnessed verbal contracts are just as binding, but cannot so readily be reviewed or referred to in case controversies arise. Day labor or other temporary help may be safely hired without great care as to details, though the terms of employment should be definitely understood by each party.

If time off is to be allowed or holidays are to be observed, the time and days should be stated. Where a large amount of confining work, such as will be found on a large dairy farm, is to be done and a number of men are employed, it is often possible to arrange for the men to take turns in doing the necessary work on Sundays and holidays. In this way, each man gets his fair share of time off, resulting in greater contentment in the crew. The stipulation of a definite time when payment will be made is often wise. This may be to suit the conditions. Provision should always be made in employing labor for the termination of the contract. Nothing is so disturbing to the farm business as a dissatisfied employee. For this reason it is best to make an elastic contract that can be terminated by either party within a reasonable time after notice has been given.

## Getting Work Done

The important thing in the management of labor is to get the work done promptly, effectively, and at the lowest possible cost. Other things being equal, the man who gets the greatest number of hours of labor from his help will have the largest income. To get the best returns from labor, the farm manager must recognize that there are two specifically different classes of enterprises for which work will be demanded. In the first class are the productive enterprises, such as preparing the soil for crop growing, caring for the crops, milking cows, feeding beef cattle or sheep, or picking fruit. Labor employed on such enterprises brings a direct return to the farm. In the second class, called nonproductive enterprises, are included such operations as the care of the farmstead and buildings, care of idle work stock, road building, and repair work. Labor employed on such enterprises cannot possibly bring direct returns to the farm. There is no way, however, of avoiding a certain amount of labor on such enterprises on any farm. The proportion of labor on nonproductive enterprises, needless to say, should be kept as low as possible. On well-organized farms with cropping systems well arranged, and with livestock in correct proportions the nonproductive or maintenance labor may be as low as 18 to 20 per cent of the total labor required. In farming under single-crop systems, the nonproductive labor may run as high as 35 to 50 per cent. This difference, applied to two farms using 6,000 hours each yearly, would mean that 1,000 to 2,000 hours more of the time of the men would be employed in producing crops and livestock on one farm than on the other. Naturally, it would be expected that larger profits would be made on the farm most usefully employing the labor. It is essential, therefore, that the farm manager keep in mind the importance of keeping down to the lowest possible limit the labor on nonproductive enterprises, and the wisdom of using his labor largely on work that will bring returns.

**Assignment of work.** Every laborer, whether hired or belonging to the family, works best when he knows in advance what he is expected to do. Therefore, each should be assigned certain definite parts of the daily routine. By repeatedly doing the same thing a person gains proficiency and can accomplish more. By having each member of the crew assigned to definite duties, confusion is avoided and loss of time as well. It is far better to have one man do the milking regularly while another cares for the horses and hogs,

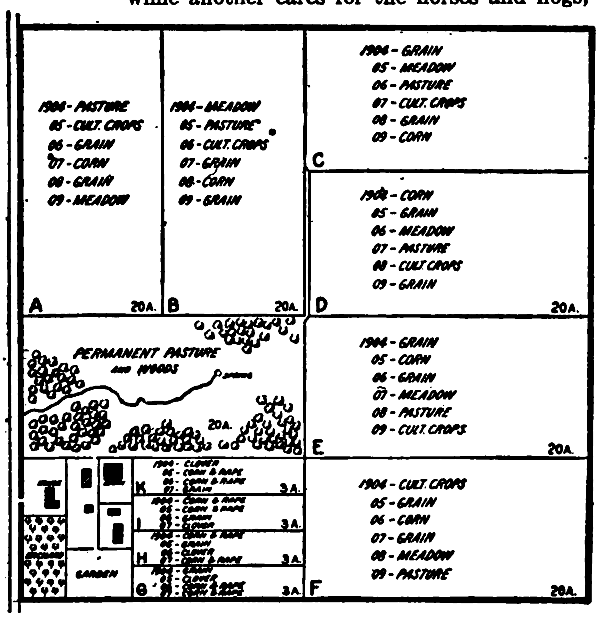



FIG. 13. Another possible plan for the farm shown in Fig. 12. The major rotation is a 6-course one, using six 20-acre fields; the minor, a 4-course one on four 3-acre fields. This does away with the hog pasture, but provides more other pasture than before.

than it is to change them about frequently. When confined to certain regular duties, men need less supervision and are more likely to become interested in their work. In this way they come to carry a part of the responsibility for getting results. In assigning the duties, care should be taken to observe so far as possible the likes and dislikes of each laborer for certain kinds of work. If one has a liking for cows rather than for horses and machinery, it is likely that he will give the best service in caring for the dairy as his share of the work. The one who likes horses and machinery should be assigned to the fields as his main responsibility. Each will, of course, have to do other things than care for his regular work, and both may have to combine on the performance of many disagreeable tasks, but both will be happier in their work for being employed the larger part of their time at work in which they are interested. In order to keep labor satisfied, it is important that the work be somewhat equally divided. If there are disagreeable tasks about the farm, these should not always be put on the same person. A combination of all on a disagreeable job, or an exchange in the order of doing it, will often smooth up the objections to such work and result in a much better satisfied crew.

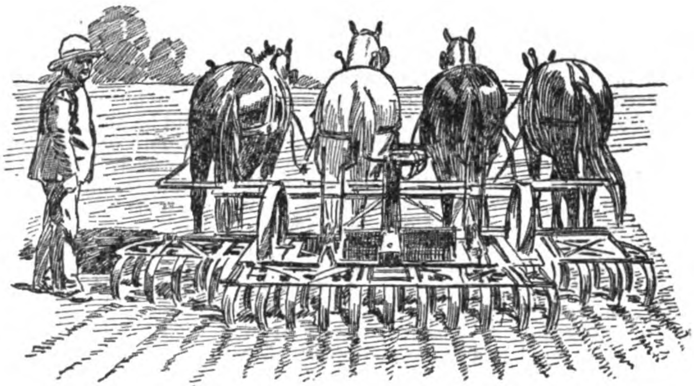


FIG. 14. Machinery should be purchased and used up to the point beyond which further expense will not bring increased crops or an actual saving of labor cost. It requires records and good judgment to locate this point.

**Directing the labor.** Most of the farm work in the United States is directed by the farmers who own and operate the land. Ordinarily the farmer performs the work in the fields or barns himself, using the help of such members of his family as are able to assist. When the amount of labor is more than can be performed by the family, he employs what is needed. In either case he himself is the manager and working foreman. No better combination can be made for getting the work done on small farms. The personal interest of the farmer himself, and often of the others, in getting the best results possible, stimulates industriousness and tends to eliminate waste and breakage. The intimate personal knowledge of all of the details of the farm business is a large factor in securing good profits.

On farms that are too large or too complicated to be operated by the farmer and his family, greater attention must be given to the supervision of the labor. Because the farm work is spread over such a large land area, it is seldom wise to employ more than 6 or 8 men without some one directly in charge as a working foreman. Usually this foreman can be picked from the crew, choosing one of the most efficient and reliable. By paying him a premium over the other men, his interest in getting a large amount of work done can be secured. On large farms where many men are employed, it may be necessary to have several such foremen. One may be put in charge of the barn work with certain helpers assigned to him, another may be given the responsibility for the field work, and still another may be put in charge of a crew engaged in making repairs and certain improvements. In this way the farmer becomes his own manager and superintendent, keeping in constant touch with the work of the farm through the foremen, and transacting the business. The foremen take the responsibility of keeping the men at their assigned duties and of having the work done as it should be. In an arrangement of this kind it is wise for the farmer or manager to deal only with the foremen of each crew, thus recognizing their positions and gaining for them the respect of the crew. In handling a crew of farm laborers it is essential that the one in charge know how to do the work himself and how much to expect in laying out a day's work for the men. When he does have this knowledge he will be able to detect shirkers and can better insist on a full day's work. He should always be on the watch for labor-saving methods and prompt to train his men to adopt them and to avoid wasted effort. If possible there should be maintained between the men themselves and between them and the foreman, a common interest in the work at hand. The foreman should be "a leader" rather than "a driver" in order to bring this about. The farm manager who can gain and hold the goodwill of his men has an asset which can be turned to good account in securing profits from his business.

**Use of machinery in saving labor.** Much

labor that was formerly done by hand is now done by machinery. Few operations on farms are done as they were 25 years ago. Most of the improvement in methods of doing farm work is due to the development of machinery. Self-binding harvesters, self-feeding blow-stacker threshing machines, gang plows, hay loaders, potato diggers and sorters, manure spreaders, milking machines, and gas engines are familiar examples of labor-saving implements. The equipment of a farm is not complete until it includes as many of these implements as the business of the farm can use profitably. There is no question but what machinery of suitable size and quality will aid materially in getting the work on the farm done promptly and in good order. Machinery should not be purchased, however, until it can be shown that it will be possible to save its equivalent expense in man or horse labor, or that it will materially aid in securing products of better quality. In determining these questions it is necessary to estimate the expense of doing the work with and without the machine. The plan should be adopted which gives the product at the lowest cost, unless the machine is wanted purely to relieve the farmer and his family from heavy drudgery.

**Daily program of work.** Farm work is subject to more sudden changes than most other lines of work. The duties of the farm are performed largely out of doors, and sudden storms or climatic changes may necessitate a change in the whole day's work. These changes cannot be made without loss of time unless substitute plans are at least partly in mind. Daily programs that may be approximately followed should be planned out by anyone charged with the responsibility of directing farm work. These should show what work is to be undertaken under fair conditions or stormy. Ordinarily they will be prepared a day or two in advance of the work. Certainly they should be prepared at least the night before. Thus, a "rainy day" program or a "cold day" program will be made up. There should also be programs for slack days in the summer season and also for the days when full time in the fields is called for. The making of such programs has two distinct advantages: (1) it helps the farmer to determine which operations should be performed first and how, allowing him to place his men to the best advantage; (2) having the plans well thought out enables him to give explicit directions promptly, thus saving time of both himself and his men. Sample programs are submitted herewith. It should be understood, of course, that the nature of the farm work will not permit following any program closely. Sick animals must be cared for, crop emergencies will arise, and numberless unforeseen circumstances will occur which will interfere with the plans. But with the plans for conducting the daily routine clearly mapped out and the work definitely organized, these interruptions may be reduced to the minimum. It should be understood that these are programs for a day's work, not records of work actually done. Few farmers will be able to carry out such programs to the minute or even to the half hour. That fact, however, does not lessen the value of the program in the least, in laying out work for the various members of the crew.

DAILY PROGRAM OF WORK ON A DAIRY FARM OF 160 ACRES (3 MEN)

4:45 A. M......Rise.
5:00– 6:30....Feed and milk cows.
6:30– 7:00....Care for other stock and prepare for breakfast.
7:00– 7:30....Breakfast.
7:30– 8:00....Clean barns, water stock, and get cows to pasture.
8:00–11:30....Field work { John, cultivate corn. Henry, hoe potatoes. Joe, hoe potatoes.
11:30–12:30....Water and care for stock, and get ready for dinner.
12:30– 1:00....Dinner.
1:00– 1:30....Rest.
1:30– 4:30....Field work. (See forenoon assignment. Joe get cows at 4:00.)
4:30– 6:00....Feed and care for cows and other stock. Milk.
6:00– 6:30....Supper.
6:30– 9:00....Recreation, reading, or social calls.
9:00..........Retire.

DAILY PROGRAM OF WORK FOR A 160-ACRE DIVERSIFIED FARM (2 MEN)

*Summer Season—Good weather*

4:45 A. M......Rise.
5:00– 6:20....Feed horses, hogs, and other livestock; clean and harness horses, milk cows; put barns in order.
6:20– 6:30....Prepare for breakfast.
6:30– 7:00....Breakfast.
7:00–11:30....Work in fields.
11:30–12:00....Return from fields, feed and water stock, prepare for dinner.
12:00–12:30....Dinner.
12:30– 1:00....Rest.
1:00– 5:00....Work in fields.
5:00– 6:00....Feed and care for stock and milk cows.
6:00– 6:30....Supper.
6:30– 9:00....Recreation; reading and social calls.
9:00..........Retire.

DAILY PROGRAM OF WORK FOR A 160-ACRE DIVERSIFIED FARM (2 MEN)

*Summer Season—Rainy day*

4:45 A. M.....Rise.
5:00– 6:20....Feed horses, hogs, and other stock; curry horses, milk cows, and put barn in order.
6:20– 6:30....Prepare for breakfast.
6:30– 7:00....Breakfast.
7:00–11:30....Whitewash barn and poultry house.
11:30–12:00....Care for stock and prepare for dinner.
12:00–12:30....Dinner.
12:30– 1:00....Rest.
1:00– 5:00....Sharpen mower sickles and overhaul mower and hay rake.
5:00– 6:00....Feed and care for stock and milk cows.
6:00– 6:30....Supper.
6:30– 9:00....Reading or recreation.
9:00..........Retire.

## Purchasing and Marketing

Storekeepers and merchants make their profits by buying at wholesale and selling at

retail. Farmers as a rule, reverse the process, buying at retail and selling at wholesale. It is in this respect that the independence of the farmer is often his downfall. Were it not for the fact that they buy but small quantities of commodities and produce nearly everything that they sell, this policy would be fatal to their business. Great improvement can be made by most farmers in their arrangements both for buying supplies and for selling their farm products.

**Individual buying of supplies.** In buying supplies, farmers as a rule deal with small retail stores in country towns. They buy in small quantities and often on time. Therefore they pay the highest price and oftentimes interest on the purchase, either directly or indirectly. A much better plan is to buy in large quantities, in unbroken lots, and for cash. There is no objection to dealing with the country storekeeper if he charges only a reasonable profit for his services as agent. It is wise always to watch the market and to learn what goods can be bought for in other places, and to stand ready to take advantage of bargains when offered. This is where a little ready cash held for operating expenses can be used to advantage.

**Buying supplies coöperatively.** Because an individual farmer needs only small quantities of most commodities that he buys, it is impossible for him to secure very low prices. The farmers in many sections are finding that by coöperation in securing supplies they are able to reduce the cost greatly. Goods bought in carload lots can be handled much more cheaply than when bought in small shipments, on which local freight must be paid. The farmers of a community can often join in the purchase of carload lots of bran, cottonseed meal, tankage, corn, or other feedstuffs. Fence wire, salt, cement, and other building material, also, may be purchased in the same way. Flour, sugar, and other household supplies may be included in the list in some communities, and where new supplies of livestock are to be introduced or a number of herd bulls are needed, coöperative buying and ownership has many advantages. Coöperative buying does not necessarily mean freezing out the retail dealer. When quotations for carlots of goods are wanted, the local dealer should be asked to figure on the order. If he can supply the goods at the same figure as a dealer farther away, he should be given the order. Often he can give considerable service in acting as the distributing agent and adjusting the bills between the purchasers. For such service he is entitled to get a commission or pay at some fixed rate. In any event, his goodwill should be retained as a member of the community, if he is fair-minded and square-dealing in other matters.

**Selling the farm products.** Few farmers market their products to the best advantage. Usually sales are made by the individual farmer when he has a product to sell or is in need of cash. In selling, but little attention is given to market fluctuations or to hunting for a market that will pay a special price for products of exceptional quality. He takes whatever he has to offer to a dealer at the local market, and takes what he can get for it. The reason for this is plain. The individual farmer can do but little to influence the market. He does not have enough of any product to market to affect prices materially. He seldom has enough to ship in large lots or in carloads to a better market. As a consequence, he is at the mercy of the local buyer. When there is no competition in the local market, the buyer has the advantage, but in most cases he pays all he can afford to for the quality of the goods offered. Good products marketed in small lots with poorer products are used to bring up the average of the shipment. The farmer who supplies the best goods does not always get their full value in selling on a noncompetitive market. Where staple products that are not perishable are to be marketed, the problem is not so serious, but without question study given to the problem of marketing would on most farms materially increase the net profit.

Whether the products are to be retailed direct to the consumer by the farmer or sold through a commission man, will depend upon the circumstances. Delivery to consumers in most cases requires special equipment and more time than the farmer can spare from the duties of growing the crop or making the product. In such cases it is best to leave the distribution to some one especially equipped for handling it and who can combine the products from many farmers, thus reducing the cost of distribution as a whole.

Careful preparation of the goods for market is an important factor in getting good values for them. It is not uncommon to find grain offered for sale which contains weed seeds, dirt, and other foreign matter. Such grain is subject to dockage and must be cleaned before it can be used. If the cleaning is left to the buyer, he must buy low enough so that he can afford to do the cleaning. In many cases, with special equipment he can do the cleaning more cheaply than the farmer can. The farmer should see, however, that he does not lose more than the cost of cleaning in selling his grain, and in growing grain, the aim should be to keep it free from weeds, keep out the dirt and foreign matter, and to produce only a product of good quality. A premium can be demanded for the best. If such goods are produced in sufficient quantities, shipment to a terminal market, when the local market refuses to pay full value, may be advisable.

Special preparation of all articles or produce should be given careful consideration. Good premiums are always paid for freshly gathered eggs, for attractively packaged but-

ter, and for cream of good quality. Special brands of hams, bacon, and other goods are often sold to advantage. Attractively dressed poultry can usually be sold at an advance over the common run. Berries, fruit, and potatoes require careful grading and shipment in attractive packages to bring the top of the market. Disease must be kept out and only good goods sent, if a market is to be permanently maintained. It is possible, of course, to fuss over the preparation of products so much as to raise the labor costs beyond the possible extra margin. Attention should be given to maintaining a regular supply and to keeping the goods up to a high standard. Nothing is more quickly fatal to a line of fancy trade than to disappoint shippers in either the expected arrival of goods or the quality of goods when they do arrive.

In selling livestock it is important to have the animals well grown and finished for the purpose of meeting a specific market. An animal in good flesh always sells better than one that shows poor care. This is especially true of horses and cattle. Attention should be given to having animals at the right age and weight when offered for the market, and the farmer who is looking for profits should avoid having animals grow old and unsalable on his hands. The individual farmer can improve the returns much by giving attention to producing the kind the market demands, to keeping his products up to a high standard of quality, to preparing them carefully and shipping them in packages suitable to the market, and by wisely selecting the best market for his goods. It is not possible for the individual to affect materially the market price for this produce. By joining his neighbors in the coöperative shipment of farm produce, frequently better prices can be secured. If the farmers of the community are to join in the shipment of their products, it is essential that they combine on the kind of a product to supply. The production of one variety of potatoes, onions, cabbages, and other vegetables will permit the shipment of carloads which are standard and which do not have to be regraded or broken up into small lots to sell to advantage. Selling, consequently, is more prompt and more likely to bring more satisfactory prices. Likewise community breeding of cattle or other kinds of livestock is a decided asset in selling the surplus stock. A community has no difficulty in attracting buyers from the outside who come because there is a large number of animals from which to make their selection. Neighborhood effort in breeding the best, in judicious advertising of the stock for sale, and in giving honest values can thus build a reputation for itself which will be reflected through the prosperity of the individual farmer. Coöperative livestock shipping associations in communities that are raising large quantities of meat stock are advisable. These insure the individual farmers getting their animals on the market with the fewest possible commissions and at the minimum cost for freight, commissions, and other services given. Many other examples of coöperation in buying and selling, and of individual effort in preparing the goods for market and placing them before the people, might be given. However, it is believed that these are sufficient to start those to thinking about the problem who are interested in improving their conditions.

Where individuals are obliged independently to find a market for their produce, consideration should be given to the merits of the parcels-post law, to express shipments, and various other methods of shipment which may permit placing the produce on the market promptly and in good condition. Light products of imperishable quality may very satisfactorily be marketed in this way, provided a line of customers can be found who are reliable and will pay a good price for the product.

FIG. 15. A farm is supported by its fertile tillable acres. Most of this land is merely a burden that has to be carried by the rest of the farm

CHAPTER 2

# Farm Records: How and Why They Should be Kept

*By* PROFESSOR ANDREW BOSS (*see Chapter 1*). *No one can run a farm like a business without keeping books and accounts in a businesslike way. A great many record-keeping systems fail, either because they are too complicated for the farmer to use or because they are so simple as to be incomplete and unable to indicate anything of importance regarding the business after they are kept. An elaborate system that gives excellent satisfaction on a large country estate, where an office force of clerks and accountants is maintained for that work alone, is not a farmer's system; it is useless to point to such a solution of his problems. Realizing this, Professor Boss has set out to tell just what a farmer should keep track of on paper, and how he can do it most easily and most effectively.*—EDITOR.

IF farming is to be done in a businesslike way, there must be systematic and efficient administration. To make this possible, it is necessary to know certain facts about the farm business. Ascertaining these facts implies the keeping of certain records. Business transactions on the modern farm are far too numerous to be kept track of accurately in one's head. A record of purchases and sales, as well as of debts and loans, may be simple and yet complete and orderly enough to show just what the farmer wants to know without much hunting. Inventories, labor records and other supplementary records are very desirable. Just what records each farmer should keep depends upon the amount and upon the type of business he is doing. The more complete and detailed the record is, the more it will show about the farm business. It will require more work to keep it also. In choosing a system of records, the fact should be recognized that the prime business of a farmer is raising crops and livestock, and not bookkeeping. The first requisite of any system of records is that it must record the essential facts. Only such facts as can be used should be included. It is confusing to have numerous accounts to which no attention is paid. Unless the records can be summarized as wanted through the year or at the end of the year, they are worse than useless and should be

INVENTORY LIST

| Machinery | Value April 1st 1917 | | 1918 | |
|---|---|---|---|---|
| 1 Separator | $ 30 | 00 | | |
| Utensils | 5 | 00 | | |
| 1 Set harness | 24 | 50 | | |
| 2 Sets heavy harness | 40 | 00 | | |
| 1 Single harness | 14 | 00 | | |
| Collars, halters, etc. | 10 | 00 | | |
| Manure spreader | 100 | 00 | | |
| 1 Buggy | 14 | 00 | | |
| Robes, blankets, sacks, etc. | 10 | 50 | | |
| Miscellaneous tools | 25 | 00 | | |
| 1 Tank heater | 1 | 00 | | |
| 1 Gas engine | 40 | 00 | | |
| 1 Wheelbarrow | 2 | 00 | | |
| Disk | 16 | 00 | | |
| 1 Gang plow | 19 | 50 | | |
| 1 Breaking plow | 7 | 00 | | |
| 2 Drags | 12 | 00 | | |
| 2 Hay racks | 11 | 00 | | |
| 3 Wagons | 42 | 00 | | |
| 1 Corn binder | 45 | 00 | | |
| 2 Cultivators | 60 | 00 | | |
| 1 Binder | 44 | 00 | | |
| 1 Rake | 13 | 50 | | |
| 1 Mower | 16 | 00 | | |
| Hay forks, slings and rope | 12 | 00 | | |
| Total Machinery | $614 | 00 | | |

FIG. 16. Sample page of an inventory, the most essential of the farm records

Cattle

| | | |
|---|---|---|
| Betsy | $ 50 | 00 |
| Clara | 70 | 00 |
| Dell | 85 | 00 |
| Ethel | 80 | 00 |
| Fay | 105 | 00 |
| Gem | 40 | 00 |
| Henrietta | 75 | 00 |
| Ida | 70 | 00 |
| Jane | 65 | 00 |
| Kate | 80 | 00 |
| 4 two-year-old heifers | 160 | 00 |
| 6 yearling heifers | 150 | 00 |
| 7 calves | 56 | 00 |
| 1 bull | 125 | 00 |
| Total cattle | $1211 | 00 |

Miscellaneous

| | | |
|---|---|---|
| Household goods | $100 | 00 |
| Supplies on hand | 68 | 00 |
| Wood, 15 cords @ $5.50 | 82 | 50 |
| Coal, 1½ tons @ $6.10 | 9 | 15 |
| Cash on hand | 20 | 00 |
| Cash in bank | 420 | 00 |
| Total miscellaneous | $699 | 65 |

Horses

| | | | |
|---|---|---|---|
| Grey Team | 4 years | $350 | 00 |
| Mare, Nell | 6 " | 100 | 00 |
| Horse, Jack | 5 " | 125 | 00 |
| Mare, Flora | 8 " | 80 | 00 |
| Mare, Kit | 10 " | 70 | 00 |
| Horse, General | 10 " | 60 | 00 |
| Mare, Bess | 1 " | 90 | 00 |
| Colt Nip | | 40. | 00 |
| Total horses | | $915 | 00 |

FIG. 17. Additional inventory pages. Values must be based on what the stock would bring at a sale, not on what they represent to the owner.

dispensed with. One should carefully study the question of what he wishes to know about his business, and then plan records, methods of keeping them, and a system of summarizing which will give him the knowledge he desires about his business. In this way, the records can be made useful in making an analysis of the business, in enabling the farmer to eliminate wasteful processes, and to discontinue the production of products which cause him a loss. If one organizes his system of records with the idea of learning where the gains and losses of the business lie and of using other useful information, there will be no question about the value of farm records. As mentioned, there is a large number of records which may be kept. Since the nature of the business of farming calls for much out-of-door employment, and leaves but little time for office or clerical work, it is essential that the accounts be as simple as possible.

The records may be classified as follows: *Essential records:* Inventory and cash account records. *Supplementary records:* Production records, labor records, feeding records, crop records, breeding records, etc.

## Essential Records

**The inventory.** The most essential farm record is the inventory. Once each year, everything of value on the farm should be listed with a value affixed. Without this most necessary record no farmer can tell how big his business is nor whether he is paying or being paid for running his farm. Cash on hand is no indication of his prosperity, because his livestock or machinery may have so increased as to make a nice profit during the year, and yet his bank account may be overdrawn. An annual inventory, too, gives a means of checking up on small tools and other property that may have been lost during the year. It will not take more than half a day once a year to take an inventory of the ordinary farm. Its value is far in excess of the cost of getting it.

**How to take an inventory.** It is best to take the inventory about March or April first on the ordinary farm, as at that time supplies of feed and salable stock are usually lowest, and there is less to inventory than at any other time. It may be taken, however, at any convenient time. It is important that the inventory be taken at the same time each year so as to include just a year's business. A value should be placed on the land and buildings separately as a start of the inventory. Unless extensive improvements have been made, the values should be the same at both ends of the year. If there has been an in-

Poultry and Bees

| | | | | | |
|---|---|---|---|---|---|
| 100 hens @ 60¢ | $ 60 | 00 | | | |
| 4 roosters @$1.00 | 4 | 00 | | | |
| 6 geese @$1.50 | 9 | 00 | | | |
| 2 turkeys @$1.50 | 3 | 00 | | | |
| 6 hives of bees @$6.00 | 36 | 00 | | | |
| Total poultry and bees | $112 | 00 | | | |

Hogs and Sheep

| | | | | | |
|---|---|---|---|---|---|
| Hogs | | | | | |
| 10 sows 2800 lbs. @ 15¢ | $ 420 | 00 | | | |
| 1 boar | 50 | 00 | | | |
| Total hogs | $ 470 | 00 | | | |
| Sheep | | | | | |
| 50 ewes @$12 00 | $600 | 00 | | | |
| 2 rams | 40 | 00 | | | |
| Total sheep | $640 | 00 | | | |

crease in value, add the increase to the net worth and include it with the opening of the next year's business. After listing the land and buildings, one of the best ways to take an inventory is to rule up some sheets of paper as shown in Figure 16, and with a supply of these go out to the barn and around the farm, listing and setting a price on everything of value, classifying the items roughly, if convenient. Everything inventoried should be put down in groups, so that it is easy to find the total value of each group, such as horses, feed, or other items of special interest. List livestock not at what it *might* sell for, but at what it would bring at a forced sale or on the established market. It should not be priced too high. In listing machinery, put it in at what it would bring at a sale, not what it would cost to replace it. Measure or weigh all feed. Put in salable feed at the market price less the cost of hauling to town; purchased feeds at the purchase price plus the cost of hauling. When everything has been listed on the blank sheets, the totals may be entered on a form such as is shown in Figure 19. A summarized inventory of this kind will tell whether the business is worth more or less at the end of the year than at the beginning, and how much, but it will not tell where the gain or loss was made. It shows no record of how much cream was sold or how much feed was bought for the cows or other stock, nor of the details of the sales and purchases. This information must be gained from the cash account.

**Cash account.** The cash account is another essential record. In recording the cash "spent" or "taken in" as a whole, it may be entered on 2 pages of a book ruled as in Figures 20*a* and *b*. This is the most simple

Feed and Supplies

| | | | | | |
|---|---|---|---|---|---|
| Oats in horse barn 61 bu @ 55¢ | $ 33 | 55 | | | |
| Oats in granary 215 bu @ 55¢ | 118 | 25 | | | |
| Barley 391 bu. @$1.15 | 449 | 65 | | | |
| Corn in crib 200 bu. @$1.60 | 320 | 00 | | | |
| Corn in barn 25 bu @$1.60 | 40 | 00 | | | |
| Seed corn 8 bu @$5 00 | 40 | 00 | | | |
| Clover hay 50 tons @$16 00 | 800 | 00 | | | |
| Silage 40 tons @$4.00 | 160 | 00 | | | |
| Oil meal 5 tons @$54.00 | 270 | 00 | | | |
| Tankage 1 ton @$65.00 | 65 | 00 | | | |
| Worm medicine for hogs | 2 | 00 | | | |
| Total feed and supplies | $2298 | 45 | | | |

FIG. 18. Early spring is a good time to take an inventory, because then the supply of feeds, etc., is likely to be at its lowest point.

form of cash record. It will tell how much was taken in and paid out during the year. If one wishes to know how much revenue the cows produced, he can go through and pick out those items such as "Cream check," "Sold Jane to Smith," etc., and by setting them

SUMMARIZED INVENTORY

Farm of H. P. White

| | Value April 1st 1917 | | 1918 | |
|---|---|---|---|---|
| Land 320 acres @ $75 00 | $24,000 | 00 | | |
| Buildings | | | | |
| House | 2,500 | 00 | | |
| Horse barn | 1,000 | 00 | | |
| Dairy barn and silo | 2,500 | 00 | | |
| Machine shed and tool house | 400 | 00 | | |
| Hog house and corn crib | 500 | 00 | | |
| Horses | 915 | 00 | | |
| Cattle | 1,215 | 00 | | |
| Hogs | 470 | 00 | | |
| Sheep | 640 | 00 | | |
| Poultry and Bees | 112 | 00 | | |
| Feed and Supplies | 2,298 | 45 | | |
| Machinery | 614 | 00 | | |
| Miscellaneous | 699 | 65 | | |
| Bills others owe me | 150 | 00 | | |
| Total Investment $ | 37,810 | 10 | | |
| Bills I owe | 8,246 | 15 | | |
| My net worth $ | 29,563 | 95 | | |
| Increase in inventory over last year | $ 652 | 00 | | |
| Increase in land value if any | 800 | 00 | | |
| Total increase for year | $1,452 | 00 | | |

FIG. 19. The summarized inventory shows just how much more or less the farm is worth than it was in the previous year, without reference to any business done during the twelve months.

down separately, may determine the income from cows. In the same way the expense of keeping the cows may be found. This plan is troublesome, however, and not nearly so satisfactory as the distributed cash record, which can be easily summarized.

**The distributed cash record.** This form of record requires a little more time to make the entries for each day's transactions, but it saves time in summarizing the records and tells much more about the farm business. In keeping this record, the items are described in a wide column at the left side of the book. The total cash receipt or expenditure should be entered in the first column to the right of the description. As many additional columns may be used as there are classes of stock or products for which a record is desired. If cows are the only thing one cares to keep special track of, only 2 columns are necessary, one for total expense and one for cows. Many farmers will want to keep a record of several enterprises. They may have columns for just as many as they have room for. Figs. 21*a* and *b* show a list of such enterprises. If it is desired to keep track of each crop, each may have a column. Labor, machinery, equipment, permanent improvements, etc. may be separated out in the same way.

The more enterprises into which the cash

1917 **RECEIPTS**

| | | | | |
|---|---|---|---|---|
| Apr | 2 | Cream check | $35 | 26 |
| | 7 | Sold a calf, 140 lbs. @ $13.50 | 18 | 90 |
| May | 9 | Sold 100 bu. corn @ 1 60 | 160 | 00 |
| | | Traded 10 doz. eggs @ 26¢ | 2 | 60 |
| June | 1 | Cream check | 40 | 15 |
| | | John Jones paid me for hogs | 150 | 00 |
| | | Borrowed at Bank | 50 | 00 |
| | 4 | Sold Kit to Hanson | 75 | 00 |
| | | Cream check | 45 | 19 |
| | 14 | Sold Jane to Smith | 75 | 00 |
| July | 6 | Cream check | 50 | 12 |
| Aug | 10 | Cream check | 40 | 74 |
| Sept | 8 | Cream check | 32 | 96 |
| | 10 | Sold heifer to Smith | 45 | 00 |
| | 18 | Helped Hanson fill silo – 2 teams | 10 | 00 |
| Oct | 7 | Cream check | 37 | 18 |
| | | Sold chickens – 200 lbs. @ 18¢ | 36 | 00 |
| Nov | 12 | Cream check | 43 | 57 |
| | | Sold 60 hogs – 19200 lbs. @ 18¢ | 3456 | 00 |
| | 18 | Sold 20 lambs – 2500 lbs. @ 16¢ | 400 | 00 |
| | | Forwarded to next page | 4803 | 67 |

FIG. 20*a*. Left-hand page of the cash account book, which is the easiest daily record to keep, but the hardest from which to get any definite, summarized facts.

**RECEIPTS**

| | Total Cash | Horses | Cattle | Hogs | Sheep | Bees & Poultry | Crops | Miss. |
|---|---|---|---|---|---|---|---|---|
| April 2, Cream check | $ 35 26 | $ | $ 35 26 | $ | $ | $ | $ | $ |
| 7, Sold a calf #140 @ $13.50 | 18 90 | | 18 90 | | | | | |
| May 9, Sold 100 bu. corn @ $ 1 60 | 160 00 | | | | | | 160 00 | |
| Traded 10 doz eggs @ 26¢ | 2 60 | | | | | 2 60 | | |
| June 1, Cream check | 40 15 | | 40 15 | | | | | |
| John Jones paid for hogs | 150 00 | | | 150 00 | | | | |
| Borrowed at bank | 50 00 | | | | | | | 50 00 |
| 4, Sold Kit to Hanson | 75 00 | 75 00 | | | | | | |
| Cream check | 45 19 | | 45 19 | | | | | |
| 14, Sold Jane to Smith | 75 00 | | 75 00 | | | | | |
| July 6, Cream check | 50 12 | | 50 12 | | | | | |
| Aug 10, Cream check | 40 74 | | 40 74 | | | | | |
| Sept. 8, Cream check | 32 96 | | 32 96 | | | | | |
| 10, Sold heifer to Smith | 45 00 | | 45 00 | | | | | |
| 18, Helped Hanson fill silo 2 teams | 10 00 | | | | | | | 10 00 |
| Oct 7, Cream check | 37 18 | | 37 18 | | | | | |
| Sold chickens, #200 @ 18¢ | 36 00 | | | | | 36 00 | | |
| Nov 12, Cream check | 43 57 | | 43 57 | | | | | |
| Sold 60 hogs, #19,200 @ 18¢ | 3456 00 | | | 3456 00 | | | | |
| 18 Sold 20 lambs, #2,500 @ 16¢ | 400 00 | | | | 400 00 | | | |
| Sold 4 doz eggs @ 30¢ | 1 20 | | | | | 1 20 | | |
| 21 Sold the bay colt | 85 00 | 85 00 | | | | | | |
| Sold 4 tons hay @ $15.00 | 60 00 | | | | | | 60 00 | |
| Dec 5 Cream check | 48 92 | | 48 92 | | | | | |
| 8 Sold 64 bu. oats @ 60¢ | 38 40 | | | | | | 38 40 | |
| Forwarded to next page $ | 5037 19 | 160 00 | 512 99 | 3606 00 | 400 00 | 39 80 | 258 40 | 60 00 |

FIG. 21*a*. Left-hand page of a typical distributed cash record. The extra minutes spent in keeping it are more than balanced by the increased information it supplies at a glance at any time

| 1917 | | EXPENSES | |
|---|---|---|---|
| Apr. | 2 | Groceries | $6 50 |
| | | Horse brushes | 1 00 |
| | | Personal | 6 15 |
| | 7 | Machine oil | 70 |
| | | Lumber | 3 15 |
| | | Clover seed #80 | 18 65 |
| | | Eggs for hatching | 3 00 |
| | 9 | Groceries (bought with eggs) | 2 60 |
| | | Salt for cows | 1 65 |
| | | Medicine for hogs | 1 00 |
| | | Bee supplies | 6 00 |
| | 14 | Personal | 2 14 |
| | | Groceries | 3 46 |
| May | 2 | Groceries | 4 76 |
| | | Dairy utensils | 50 |
| | | Screenings for sheep #2070 | 6 21 |
| | | Grinding feed | 2 00 |
| | | Colt service | 15 00 |
| | | Real estate taxes | 36 40 |
| June | 1 | Paid Cameron Bros on account | 300 00 |
| | | Forwarded to next page | 420 87 |

FIG. 20*b*. Right-hand page of the cash account book. Aside from the necessity of having such a record, it is an excellent thing to get into the habit of keeping it.

account is divided, the more work it is to keep the records. It is better to have a few accounts kept right than a large number kept for a month or two and then abandoned as too much work. It is essential that entries in the books be made daily; for, if the bookkeeper once gets behind, it is almost impossible to catch up. It is a good plan to keep the book near the dining-room table and enter the accounts every night before leaving the supper table. It takes only a very few minutes, and in this way it is pretty sure to be done. The transactions are fresh in mind, also, and can be more accurately entered. It is easy to see then how a cash record kept by this method, called the single-entry system, can be made simple or complex according to the number of separate accounts kept. If so many enterprises are listed separately that there is not room for them on one page, they may be extended across both pages. In order to keep a year's record of each together, several pages should be left for "Receipts" and in another place several more pages for "Expenses."

In order to find out how each enterprise has come out financially, it is only necessary to add up each column. To learn the true earnings of the enterprise, add the opening inventory of the enterprise, to the expense side and the closing inventory to the receipts side. The difference between the two footings will show whether or not the receipts exceed the expense. If so, this may be counted as gain. If the total receipts do not

**EXPENSES**

| | Total Cash | Horses | Cattle | Hogs | Sheep | Crops | Personal & Household | General Expense |
|---|---|---|---|---|---|---|---|---|
| Apr. 2, Groceries, personal & horse brushes | $ 13 65 | $ 1 00 | $ | $ | $ | $ | $ 12 65 | $ |
| 7, Machine oil .70 Lumber 3.15 | 25 50 | | | | | | | 3 85 |
| Clover seed #80 | | | | | | 18 65 | | |
| Eggs for hatching | | | | | | | | 3 00 |
| 9, Groceries (bot with eggs) from Jones | 2 60 | | | | | | 2 60 | |
| Salt for cows | 1 65 | | 1 65 | | | | | |
| Medicine for hogs | 1 00 | | | 1 00 | | | | |
| Bee supplies from S. R. & Co. | 6 00 | | | | | | | 6 00 |
| 14, Personal | 2 14 | | | | | | 2 14 | |
| Groceries, Powers Co. | 3 46 | | | | | | 3 46 | |
| May 2, Groceries from Jones | 4 76 | | | | | | 4 76 | |
| Milk pail | 50 | | | | | | | 50 |
| Screens for sheep #2070 | 6 21 | | | | 6 21 | | | |
| Grinding feed for hogs | 2 00 | | | 2 00 | | | | |
| Colt—Service fee Joe Carey | 15 00 | 15 00 | | | | | | |
| Real estate taxes | 36 40 | | | | | | | 36 40 |
| June 1, Cameron Bros on acct. Machinery | 300 00 | | | | | | | 300 00 |
| Groceries Jones | 4 87 | | | | | | 4 87 | |
| 8, Cultivator repaired | 5 00 | | | | | | | 5 00 |
| Nails | 50 | | | | | | | 50 |
| 30, Gasoline | 2 00 | | | | | | | 2 00 |
| Pump repaired by Ed. Smith | 70 | | | | | | | 70 |
| Forwarded to next page | $ 433 94 | 16 00 | 1 65 | 3 00 | 6 21 | 18 65 | 30 48 | 357 95 |

FIG. 21*b*. Expense page of the distributed cash record. While the difference between the right- and left-hand columns for any one department indicates how it is progressing, its real financial condition is found only by adding or subtracting the increase or decrease in value as shown by the inventory.

## LEDGER CATTLE ACCOUNT

| Outgo | | | | | Income | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Apr | 1 | Inventory | $1211 | 00 | Apr | 2 | Cream check | $35 | 26 |
| | 9 | Salt for all | 1 | 65 | | 7 | Sold calf | 18 | 90 |
| July | 12 | Bought cow from Thomas | 95 | 00 | | | #140 @ $13.50 | | |
| | 14 | Put 30 tons clover hay | | | June | 1 | Cream check | 40 | 15 |
| | | in barn | 480 | 00 | | 4 | Cream check | 45 | 19 |
| Aug | 15 | Veterinary for Ethel | 5 | 00 | | 14 | Sold Jane to Smith | 75 | 00 |
| Sep | 28 | 5 mos. pasture charge | 63 | 75 | July | 6 | Cream check | 50 | 12 |
| Oct | 3 | Cost of filling silo | 62 | 15 | Oct | 1 | Sold 5 fat cattle | 571 | 95 |
| | 7 | 10 tons middlings | | | | | #6150 @ $9.30 cwt | | |
| | | @$40 | 400 | 00 | Dec | 31 | Inventory | 1,700 | 00 |
| Dec | 31 | Net profit | 218 | 02 | | | $ | 2,536 | 57 |
| | | $ | 2536 | 57 | | | | | |

FIG. 22. Sample page from a double-entry farm-record system. This has the disadvantage of requiring two notations, on different pages, for each item; but it is the surest method for finding which departments of the farm are paying and which are losing, and how much.

exceed the expense, there has been a loss. Any new stock, equipment, or produce will show as so much cash returned by that enterprise. Thus, suppose that receipts from cattle were $600 and expenses for the year $850. This would look like a loss on cattle, unless we added to it the fact that the cattle were worth $1,211 at the beginning of the year, and $2,200 at the close. The profit of $739 on that enterprise is found in the barn instead of in the bank.

**The double-entry system.** Some farmers who have kept the simpler forms of records successfully may want to trace out more carefully still the sources of profit and loss. In the single-entry system described, nothing except the inventory was taken into consideration unless it was a cash transaction. The cattle were not charged for the hay they ate. Cattle may have shown a profit, while, if they had been charged with the feed they ate, the labor put on them, the cost of keeping a barn to shelter them and the money that would have come in as interest if the cattle had been sold and the money put in the bank, they would have shown a loss. To keep track of these exchanges which do not use any money, a double-entry or ledger system is better adapted. The double-entry system involves the use of a *daybook*, also called a *journal*, in which are recorded all of the transactions as they occur. These may include cash purchases or sales, or the delivery of hay, corn, or other feed from a certain field to a certain class of livestock. From the journal these records are posted to ledger accounts with the various crops or enterprises about which it is wished to know the details of profit. A sample ledger page is shown in Figure 22. The difference between the "*Income*" and "*Outgo*", plus or minus the difference in *Inventory*, should show the profit made or the loss sustained on each account.

The double-entry system may be made simple or difficult, according to the number of separate accounts that are kept. It gives a much better idea of just where the profit or loss occurred than does the single-entry system, but does not tell any better the profit or loss from the business as a whole. It requires labor records for men and horses to get the actual costs on crops, livestock, etc., and this makes more figuring than most farmers are willing to do. For this reason the double-entry system is not recommended for general farm use except by those who wish to go into details. Where the farm is large enough to employ a bookkeeper, the double-entry system is by far the best. For a detailed discussion of this system, see Prof. G. F. Warren's "Farm Management" or any good text on bookkeeping.

## Supplementary Records

The foregoing records are considered essential to the businesslike management of a farm. From studying and summarizing these records it is possible to learn whether or not the farm as a whole has paid a profit. Production

## MILK AND FEED RECORD

THIS SHEET IS PLANNED TO BE USED AS A WEEKLY RECORD WHEN EVERY MILKING IS WEIGHED. IT MAY BE USED AS A MONTHLY RECORD IF ONLY OCCASIONAL MILKINGS ARE WEIGHED, AS INDICATED IN NOTE BELOW.

HERD OF.................................. FROM.............. 19...., TO.............. 19....

| COW-NAME AND NUMBER | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | REMARKS. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | | lbs. test | lbs. test | lbs. test | lbs. test | lbs. test | lbs. test | lbs. test | lbs. test | lbs. test | lbs. test | |
| | A.M. | | | | | | | | | | | |
| | P.M. | | | | | | | | | | | |
| TOTAL | | | | | | | | | | | | |
| GRAIN | | | | | | | | | | | | |
| ROUGHAGE | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |
| | | | | | | | | | | | | |

| Kinds of Grain Fed. | Parts in Mixture | Price | Kinds of Roughage | Price |
|---|---|---|---|---|
| | | | | |
| | | | | |
| | | | | |
| Ave. price per lb. | | | | |

IF MILK IS NOT WEIGHED EVERY MILKING WEIGH AT LEAST MORNING AND EVENING ON THE 1st, 10th AND 20th OF EACH MONTH.
AN INDIVIDUAL COW RECORD FOR BOTH THE MONTHLY AND YEARLY SUMMARY IN PAMPHLET FORM IS USED WITH THIS SHEET

FIG. 23. Monthly combined feed and milk record (centre omitted to save space) for a farm where dairying is an important activity

records and others are desirable for a more complete knowledge of the details of management. A discussion of some of these follows.

**Milk record.** If a farmer is specializing in any line of work such as dairying, he may be especially anxious to know just what his cows are doing. He may then keep special records to show what he wants to know. If production is what he wants, he may use a weekly milk sheet like that shown in Figure 23. This form also allows room for a feed record. From this it is simple to figure the feed cost and the value of produce from each cow or from the herd. This will not include labor, shelter cost, bull, veterinary, and interest charges, which must be kept track of or estimated to find just what profits are being made from each cow. It has been found from experience that a morning and an evening milk record, taken twice or three times a month, will give almost as accurate results as when taken every day. The trouble is, it is likely to be forgotten or neglected. It is best to weigh the milk from each cow regularly night and morning. Once or twice a month is often enough to test the milk of each cow for butter-fat content.

**Egg record.** An egg record is easily kept, if a form something like Figure 24 is tacked up in the kitchen or the poultry house and a pencil kept handy, so that the number of eggs

## EGG PRODUCTION RECORD

| Av. no. Hens | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | JAN. | FEB. | MAR. | APR. | MAY. | JUNE | JULY | AUG. | SEPT. | OCT. | NOV. | DEC. | REMARKS |
| 1 | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | |
| 31 | | | | | | | | | | | | | |
| Total | | | | | | | | | | | | | |
| Avg. Per Hen | | | | | | | | | | | | | |

FIG. 24. An egg record, carefully kept, is as necessary in weeding out poor layers as is the Babcock test in weeding out boarder cows

**REGULAR WORKERS DAILY TIME SHEET**

Day of Week *Monday* Date *Sept. 24*, 191*7*.

| Time | KIND OF WORK | No. Loads | Field | Man Hours | Horses No. | Horses Hours |
|---|---|---|---|---|---|---|
| 4.30 | | | | | | |
| 5.00 | *Feeding horses* | | | *½* | | |
| 5.30 | | | | | | |
| 6.00 | *Milking* | | | *1* | | |
| 6.30 | *Breakfast* | | | | | |
| 7.00 | | | | | | |
| 7.30 | *Cleaning barn* | | | *½* | | |
| 8.00 | | | | | | |
| 8.30 | *Hauling green corn* | *2* | *B* | *1½* | *2* | *3* |
| 9.00 | *for cows* | | | | | |
| 9.30 | | | | | | |
| 10.00 | *Plowing* | | *D* | *2½* | *5* | *12½* |
| 10.30 | | | | | | |
| 11.00 | | | | | | |
| 11.30 | | | | | | |
| 12.00 | *Watering stock* | | | *½* | | |
| 12.30 | *Dinner* | | | | | |
| 1.00 | *Rest* | | | | | |
| 1.30 | | | | | | |
| 2.00 | | | | | | |
| 2.30 | | | | | | |
| 3.00 | *Hauling manure* | *5* | *C* | *4* | *3* | *15* |
| 3.30 | | | | | | |
| 4.00 | | | | | | |
| 4.30 | | | | | | |
| 5.00 | | | | | | |
| 5.30 | *Milking* | | | | | |
| 6.00 | | | | | | |
| 6.30 | *Feeding & care of horses* | | | *1* | | |
| 7.00 | | | | | | |
| 7.30 | *Care of hogs & calves* | | | *½* | | |
| 8.00 | *Supper* | | | | | |
| 8.30 | | | | | | |

Workman *Elmer Harrison* Total Hours *13* ....... *30½*

Remarks Report OK *E.T.*

FIG. 25. To know the actual cost of a crop we must know how much labor was expended in raising it. A record like this tells the story.

gathered each day can be marked down as they are brought in.

**Labor records.** A labor record, showing the hours put in by men and horses on each crop, the live-stock, or other enterprises, is of great value, if one wishes to study the cost of producing his products. It is convenient also as a record of where labor has been used, even though it may not be used to determine the cost of production. Several forms for keeping labor records have been devised. The best one to use depends much on what is to be done with it finally. One of the most popular is the diary form of record shown in Figure 25. In using this form each laborer or hand puts down daily the time he has expended on various enterprises. The record is divided into one-fourth hour periods so that an accurate division can be made. This form is quite useful in stimulating interest in the work when once started, and keeping the record has a tendency to induce each laborer to make better use of his time, especially if it is to be reviewed by his employer or a foreman. In making use of this sort of a record it is necessary to pick out the items charged up against any particular field or product to learn how much time in all has been required. This is a laborious process and seldom done except by a clerk or bookkeeper.

Another form that has the advantage of distributing the time as

**MONTHLY FEED RECORD** Month *April*

| | HORSES | | | | COWS | | | HOGS | | | | POULTRY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Kind of feed | *Hay* | *Corn* | *Oats* | | *Hay* | *Silage* | *Shorts* | *Corn* | *Skim milk* | | | *Grain* | | |
| Ave lbs. daily per head | *15* | *6* | *8* | | *20* | *30* | *6* | *3* | *4* | | | *.1* | | |
| Number days fed | *30* | *30* | *30* | | *30* | *30* | *30* | *30* | *30* | | | *30* | | |
| Total lbs. per head | *450* | *180* | *240* | | *600* | *900* | *180* | *90* | *120* | | | *3* | | |
| Ave. no. head fed | *5* | *5* | *5* | | *12* | *12* | *12* | *18* | *18* | | | *140* | | |
| Total lbs. per month | *2250* | *900* | *1200* | | *7200* | *10800* | *2160* | *1620* | *2160* | | | *420* | | |
| Price per lb. or bu | *½¢* | *1½¢* | *2¢* | | *½¢* | *Ton $3.00* | *2¢* | *1½¢* | *¼¢* | | | *1½¢* | | |
| Value of feed $ | *11.25* | *13.50* | *24.00* | | *36.00* | *16.20* | *43.20* | *24.30* | *5.40* | | | *6.30* | | |

Remarks *Hay is mixed clover and timothy*
*Grain for chickens is 4 parts corn, 4 parts wheat screenings, 4 parts buckwheat*

FIG. 26. Sample columns from a monthly feed record. Without a series of such reports for each department, an accurate knowledge of the whole farm enterprise is impossible.

When the problem of how best to grow the crop ends, then begins the problem of how best to dispose of it

Marketing takes time that might be given to crops or stock. The purpose of the middleman is to do it quicker, better, and more cheaply than the farmer can

**PRODUCTION IS BUT HALF OF THE FARMER'S BUSINESS; NOT UNTIL HE HAS MARKETED WHAT HE HAS RAISED CAN HE BEGIN TO LOOK FOR PROFITS**

Industry　　　Independence　　　Patience

AMONG THE QUALITIES THAT A GOOD FARMER MUST POSSESS, THESE THREE STAND SUPREME: THE WILL AND POWER TO WORK; THE VIRTUE OF STANDING ON ONE'S OWN FEET; AND THE ABILITY TO WAIT FOR AND ACCEPT GRACEFULLY WHATEVER NATURE HAS TO OFFER

MONTHLY LABOR RECORD OF Guy Case

Month July 1917 Farm Hillside Farm Total wages paid for month $35.00 and Board

| Field | A-Corn | | | B-Oats | | | C-Hay | | | X-Potatoes | | | Orchard | | | Pasture | | | Manure | | | Equipment | | | Perm. Imp. | | | Gen. Farm | | | Cattle | | Horses | | Hogs | | Sheep | | Poultry | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | Oper | M. | H. | Oper | M. | H. | Oper | M. | H. | Oper | M. | H. | Oper | M. | H. | Oper | M. | H. | Field | M. | H. | Kind | M. | H. | Oper | M. | H. | Oper | M. | H. | M. | H. | M. | H. | M. | H. | M. | H. | M. | Man | Hours |
| 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | C | 8 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | R.D | 2 | 4 | 2 | — | 1 | | | | | | | | |
| 3 | C | 4 | 8 | | | | | | | C | 3 | 6 | | | | | | | | | | | | | | | | | | | 2 | | | | ½ | | | | ½ | | |
| 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | | | | | | | Ct | 6 | 12 | | 2 | 4 | | | | | | | | | | | | | | | | | | | 1 | | | | 2 | | | | ¼ | | |
| 31 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Total Hours | M. | H. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Labor Cost | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

SYMBOLS P-Plowing D-Disking H-Harrowing Hq-Hoeing C-Cultivating W-Weeding Ct-Cutting R-Raking Sh-Shocking St-Stacking Ck-Cocking Pk-Picking Hk-Husking S-Seeding Pl-Planting T-Threshing Hl-Hauling Dq-Ditching Tq-Tiling F-Fencing RD-Road Drag

FIG. 27. A record of this kind must be planned to meet the needs of the particular farm. It is most accurate if kept by the owner or foreman from weekly data supplied by the hired hands

entered, is shown in the monthly report (Figure 27). One of these blanks can be given to each hand with the requirement that he keep the record, or better, one can be kept for each hand by the farmer or foreman. It will be noted that there are blank columns in which can be written the names of the fields and crops, or of special classes of livestock. There are also columns for general farm expense and other charges. The price paid for the labor should be entered in the upper right-hand corner where space is provided. To make the record more complete, the operations are shown on the left margin with suitable abbreviations. The abbreviations may be entered in the first column for each enterprise in explanation of the work done. This form of report saves hunting for time charges and saves turning over pages to find the enterprise. The monthly reports may be summarized as completed and all brought into a final summary at the end of the year. There is a good deal of work in keeping an accurate labor record, and it is advised only when specific use is to be made of it.

**Feeding record.** An approximate record of food consumed is very desirable, if not actually necessary, in determining the profits from any class of livestock. While it is possible to estimate from feeds purchased and grown, less the amount on hand, about what feedstuffs have been consumed, the estimate does not show accurately the distribution of feed. A simple feed record in which the amounts used by the different classes of animals is entered, is advised if a true knowledge of the results is desired.

A feeding record may be taken in two ways. One is to weigh up the feed given each animal once a week, or once a month, and then get the number of days fed and the number of animals it was fed to. In this way, the feed for the month can be very closely calculated. Figure 26 shows a monthly record of this kind. A yearly summary can easily be made from the monthly records. The other way is to charge the feed in bulk. For instance, if 10 tons of hay and 200 bushels of oats are put in the horse barn for horse feed, make one charge for it, and nothing further need be done until they are gone. Whichever way is the most convenient is the one to use.

**Crop record.** A crop record is not hard to keep, and is of value in comparing yields and values in succeeding years. The record may be more or less complete than the one shown in Figure 30, depending on what the farmer wants to know. It may be made to include depth and time of plowing, depth and time of seeding, time of harvest, weather conditions, etc., or it may be cut down to seed sown and crop harvested.

**Breeding record.** A breeding record is almost a necessity on the stock farm. A card catalogue is a convenient form for purebred stock, each breeding animal having a card on

**SWINE**

Name Princess X No. 21726 Tag DJL 22
Date Farrowed Apr. 26 No. in litter 7 Sex 4B-3S.
Description Black except on feet and nose. Ear notched

| | | Year | Inv. Val. | Val. Pigs | Cost | Profit |
|---|---|---|---|---|---|---|
| | Prince George 18271 | 1914 | 50.00 | 207.00 | 123.00 | 84.00 |
| Sire Big Prince 19763 | Big Susie | | | | | |
| | Duke Alg. 19241 | | | | | |
| Dam Dutchess X 20122 | 19421 | | | | | |
| | Dutchess A 18462 | | | | | |

Remarks

**BREEDING RECORDS PIGS**

| Year | Boar | Date Farrow | Sex | Disposition | Value |
|---|---|---|---|---|---|
| 1914 | Big Bowe Jr. | Apr. 2 | M | Sold for Pork | 22.00 |
| | | | F | " " " | 20.00 |
| | | | F | Kept for Brood Sow | 40.00 |
| | | | F | " " " " | 35.00 |
| | | | F | Sold to Frank White | 40.00 |
| | | | M | Sold to Eli Duwhe | 50.00 |
| | | | M | Died | — |

FIG. 28. Two sides of a card on which the complete history of a pig can be kept. Such a record is indispensable in pure bred operations

which the date of birth, description, etc., are given, and room left for the date when bred, sire used, and date young are born. In the case of hogs and sheep, it is also important to know the number of young produced and the sex. The card index (Fig. 28) makes the comparison of records easy, but means more work than some variation of the form shown in Figure 29.

In discussing farm records no attempt has been made to show all of the different forms of records that may be used. Only those essential to recording and interpreting a simple farm business have been included; they can be adapted to many different kinds of farms and will prove useful and as simple as any. With the farmer it is less a question of having every

**BREEDING RECORD** YEAR 1917

| Mares | Cows | Sheep | Hogs | Sire Used | Date Bred | Date Due | Dropped Young | Sex |
|---|---|---|---|---|---|---|---|---|
| Nell | | | | Bismark | Apr. 2 | 1918 Mar. 7 | Mar 9 | M |
| | Belle | | | Beaumont | Nov. 1 | July 9 | July. 7 | M |
| | | No. 72 | | Mac | Nov. 5 | Apr. 4 | Apr. 4 | 2 F |
| | | | No 14 | Pride | Mar 1 | Jun. 22 | June 23 | 3 M 5 F |

FIG. 29. A breeding record with which the activities of all the livestock departments can be kept on a single sheet

Farm of Geo. White
Crop Oats Field B Acres 17.6
Amount seed 44 bu. Per acre 2½ bu. Value @ .90 $39.60
" Twine 40 lbs. Per acre 2½ lbs. Value @ .13 - $4.40
Grass seed sown Red clover Amount 102 lbs.
Value $20.40 Threshing cost — Per bu. 4¢
Yield: Machine measure 852 bus.
Weight ____ , Tons ____
By-product 21 tons straw (est.)

FIG. 30. Sample crop-record card that supplies both a record of past accomplishments and a basis for future plans

| Type | Records Kept | Results Obtained |
|---|---|---|
| I<br>Elementary | 1. Inventory | Shows increase or decrease in capital which shows personal gain or loss. |
| II<br>Simple | 1. Inventory<br>2. Financial Accounts | 1. Increase or decrease in capital.<br>2. Farm profit or loss.<br>3. Household and personal expense.<br>4. Distribution of receipts and expenses.<br>5. Farmer's labor income. |
| III<br>Complex | 1. Inventories<br>2. Financial Accounts<br>3. Labor Records<br>4. Livestock and feed, production records<br>5. Supplementary notes to 3 and 4. | 1. Increase or decrease in capital.<br>2. Farm profit or loss.<br>3. Household and personal expense.<br>4. Distribution of receipts and expenses.<br>5. Farmer's labor income.<br>6. Exact distribution of cost.<br>7. Exact distribution of income.<br>8. Cost, income, and profit of each group of livestock.<br>9. Cost, income, and profit of each field crop. |

cash, feed, and labor charge accurately entered than of having a correct knowledge of the year's business. Many of his accounts are with crops and stock instead of with men, and a few dollars apparent loss on crops and gain on his stock does not affect the profits from his farm, even though it may not be quite fair to his crops.

For the benefit of those who want a comprehensive method of record keeping, we reproduce above an outline taken from Farmers' Bulletin 511, U. S. Department of Agriculture, Washington, D. C., which may be obtained on request. Prepared forms for almost any style of record may be purchased from publishers and bookstores.

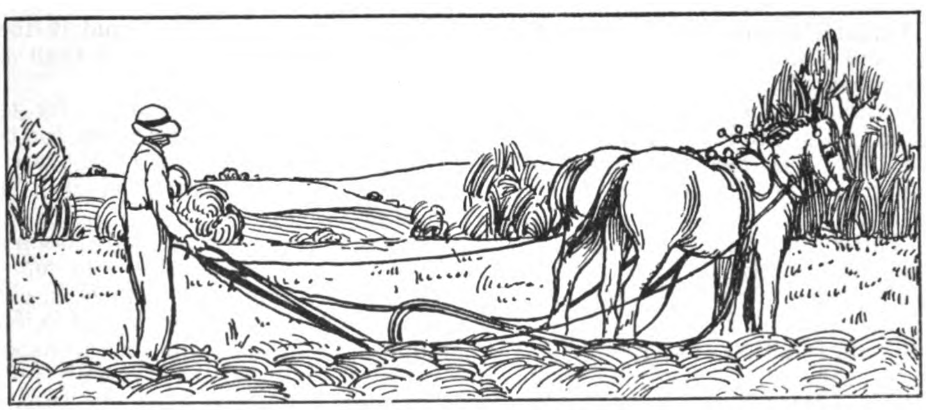


Fig. 31. It has been found that where it cost $2 per acre to plow this way, it cost $1.25 per acre when a three-horse, two-furrow plow was used. Careful records of such data as this are essential features of successful business-farming

## CHAPTER 3

# The Farmer and His Money

*By* SAMUEL D. GROMER, *Professor of Rural Economics of the College of Agriculture of the University of Missouri; a man who knows the scientific side of the subject, but who, as owner and operator of a successful farm, knows also its practical applications and everyday problems.*

*The farmer of yesterday was so aloof from the usual activities of business and commerce that his need of money and his knowledge of the principles under which it is made and used were relatively slight. He dealt but little with the outside world; most of his transactions were in the nature of barter or simple exchange of goods; and, since his neighbors were in the same condition as himself, there was as little opportunity as there was need for him to borrow cash. Later came new sources of money and new needs, and on their heels, mortgages and other results of borrowing. But the farmer learned the ways of finance, if at all, by sad experience rather than as a part of his education designed to prepare him for the management of his affairs.*

*The farmer of to-day, being a full-fledged business man, and carrying on an industry as complex and diverse as that of any merchant or manufacturer, must have a fuller knowledge of these things; he must know not only how to make, keep, and use his money, but also just what it stands for, what determines its value and purchasing power, what relation it holds to other factors in the affairs of men and the nation. It is these somewhat unfamiliar but highly important matters that Professor Gromer discusses.*—EDITOR.

FARMERS are more directly interested in money—what it is, what it does, and what it can do—and how they can make the best use of it than are any other group of producers.

Production is carried on primarily for exchange, for the market, for the value of the product to others, and not for any utility it may possess for the producer. He does not intend to consume it. Without exchange what would the farmer do with his surplus livestock, grain, and other farm products? To facilitate exchange a medium of some sort is necessary.

Different articles, such as shells, tobacco, etc., have been used for this purpose, but finally all have been ousted by the precious metals—gold, silver, and copper. Now gold has come to be the chief medium of exchange in civilized countries. This is due to its possession of 2 properties which enable it to fulfill its function better than any other object, namely, facility of transport and durability. It contains great value in small bulk and is chemically unalterable. Its value varies but little from place to place and from one time to another. This medium of exchange is denominated money, and by means of it all desired or needed objects may be reduced to a common denominator and added, subtracted, measured, and compared directly without the difficulties involved in barter.

Our standard of value is the dollar containing 25.8 grains of gold, nine tenths fine. Our gold coins would be undiminished in value, were they melted into bullion. This is not true of our other metallic money, and our paper money is practically worthless as paper. The American gold dollar is a type of a perfect money, but not so our other moneys. The latter depend more or less for their value on the belief that they can be exchanged for gold. If issued in such amounts that the public would lose confidence in its being able to exchange them for gold, they would fall in value.

The money of our country (not considering the hoard in the treasury) may be divided into 2 parts: (1) money in circulation and (2) money in banks, the two being approximately equal. The money in circulation consists of all money used in payment for goods purchased and is in the pockets and purses of the people and in the tills of the merchants. The cash in the banks, or reserve, as it is called by the bankers, is used by them to make certain the payment of deposits as they are demanded by depositors. Much of the deposits have been loaned, and these loans are based on the property of the borrowers. The borrowing property owner has only to deposit what he borrowed, on which he has a right to draw checks, and his comparatively unexchangeable property circulates and performs the function of money. In our country the bank deposits are about 5 times as large as the banks' cash or reserves, and circulate more than 3 times as fast as money.

**Farming conditions after the Civil War.** The farmer's business has not been overremunerative. Following the Civil War the liberal policy of the government with reference to the public lands made it possible for anyone with the ordinary industry of the farmer to secure a farm. The land was fertile and abundant, in a climate well suited to the white race, and with resources peculiarly suitable for its occupation by a hardy people. Many persons took advantage of this opportunity, including thousands of men who had fought in the Civil War and numerous immigrants from Europe. The fertility of the soil was the accumulation of ages undisturbed by man; the area open to settlement was as large as half of Europe. This period was marked by the invention of labor-saving machinery, such as the reaper, mower, cultivator, steel plow, and the corn planter, by means of which farming could be carried on with much less man power.

Such favorable conditions for the production of large amounts of agricultural products in proportion to the population had never been known before and probably never will be known again. Their result was an excess of agricultural products. Corn sold for a few cents a bushel; chickens as low as 75 cents a dozen; hogs for 2 cents a pound; horses and cattle could be had for a song. Many vegetables were so plentiful that they rotted in the fields and gardens. Land was cheap in many places, even though there was no public land near. Late in the seventies a man rigged up a covered wagon outfit and left the rich prairie region of northwest Missouri, where unimproved land was worth $5 per acre, to go to northeastern Kansas, where similarly fertile land was worth $2.50 per acre. There was no money in farming. The settlers understood this. They were unable to make money out of their crops, but they were making farms.

The consumer in the city got his food at unheard-of low prices. He became used to such prices, and now he seems to think that they are his by right. He has failed to appreciate the economic and social changes that have taken place—exhaustion of the public domain, an increased population, and the growth of monopolies. Cheap agricultural products have probably disappeared forever.

The uncontrolled forces of nature are a prime factor in determining the amount and quality of farm products. If nature acts kindly toward the farmer and he produces bumper crops, there is likely to be such an abundance as to impoverish him; while, on the other hand, if nature acts niggardly and his crops are smaller than the average, while he may profit financially, the consumer is impoverished and the cry at once goes up that the farmer is getting rich; that the single tax should be put in operation against him to take care of the so-called unearned increment, and that the price of his products should be fixed by law. Superficial thinking carries the day. The true principles governing the situation are either not understood or are cast aside as trash.

**Gregory King's law.** When we stop to think it over, it is easy to understand that the amount of food required, or that can be consumed, to satisfy the body's want, is strictly limited in amount. If the farmer pro-

duces more wheat than is normally required to appease all appetites, the price falls out of all proportion to the amount of excess; similarly, if he fails to produce enough, the price rises. A scale of ratios governing the increase or decrease of amount and the resulting increase or decrease in price was worked out by Gregory King several hundred years ago. It showed that an increase or decrease of 0.1 on an article of prime necessity, as such wheat product, lowers or raises the price 0.3; that an increase or decrease of 0.3 in product affects the price 1.6; that a 0.5 increase or decrease in product makes a difference of 4.5 in price, and so on. The application of Gregory King's law to the world shortage of agricultural products in 1916 and 1917, the enormous increase in our circulating medium and the consequent cheapening of the dollar, and the increased demand due to the war, easily account for the world's high prices.

**The farmer and farming statistics.** It is highly important that the farmer should have a comprehensive knowledge of the amount of the world's output of agricultural products, the world's probable demand for them, and the subsequent price at which these products will probably be consumed, based on the law of supply and demand. If the United States Department of Agriculture could furnish this information promptly and in simple form, it would render the farmer an enormous service. It was a lack of this information, and of even a reasonable approach to it, that caused the farmer to sell his wheat for around $1 in 1916, whereas later it sold for considerably more than $3, and to sell his corn for around 75 cents, whereas a few months later it reached a price on the farm of more than $2 per bushel.

The best of our land suited for grain is already in cultivation and much of it is badly worn. Prices have been so low that the farmer has not been able to maintain the fertility of the soil. While it is true that there is much land of which not much use is made, yet this is the poorest land and can be profitably made use of only when labor is plentiful and the prices of agricultural products are high enough to justify it.

The adjustment between the population of the city and that of the country has been undergoing a change since colonial times, the city gradually gaining on the country until now (1917) in the United States it is about 50–50 between them. This was satisfactory under normal conditions. It made possible a fair division of labor to the mutual advantage of country and city. While in many respects the farmer's standard of living was too low, his position was gradually becoming better. His numbers grew relatively less with the improvement of machinery and his per capita production increased. This constant adjustment of the balance between the rural and city parts of our population is of the utmost importance to the continued prosperity of both. Owing to the war, the adjustment has been thrown out of balance in favor of the farmer; but, with a good opportunity for permanent economic, social, and scientific improvement, all may yet be well. It should result in a higher standard of living for the farmer after the war.

Back of unsatisfactory economic, social, and scientific conditions in the country, school facilities are still poor and unsuited to the country's needs. Among these unsatisfactory conditions are: inadequate modern improvements such as plumbing and heating in the home; a decaying rural church; local institutions insufficiently centralized and in too small units; failure to apply the scientific discoveries of the agricultural colleges; and failure to use proper business methods, due largely to lack of coöperation. The Federal government's idea of road building, agricultural extension, and industrial schools, 50–50 for the government and the local unit, works satisfactorily.

Lack of capital has much to do with holding back the country. Money is of more importance to the farmer than to other classes. The baker usually bakes every day, except Sunday. If he is running on borrowed capital for his product, he has only to pay interest 1 day or for one three-hundred-and-sixty-fifth of a year. If the rate of interest is anywhere within reason, the baker will not be much interested, because, calculated on each loaf of bread for but one day, it will affect its price but little. The groceryman has in the neighbourhood of 6 turnovers a year. If he is running on borrowed capital, he will have to pay not more than 2 months' interest on each turnover, an amount of no great importance. With the farmer it is different. Including the equipment his annual turnover would be on an average in the neighbourhood of one-sixth of the investment, or 1 complete turnover in 6 years. This is a serious matter. To determine the rate at which he could profitably

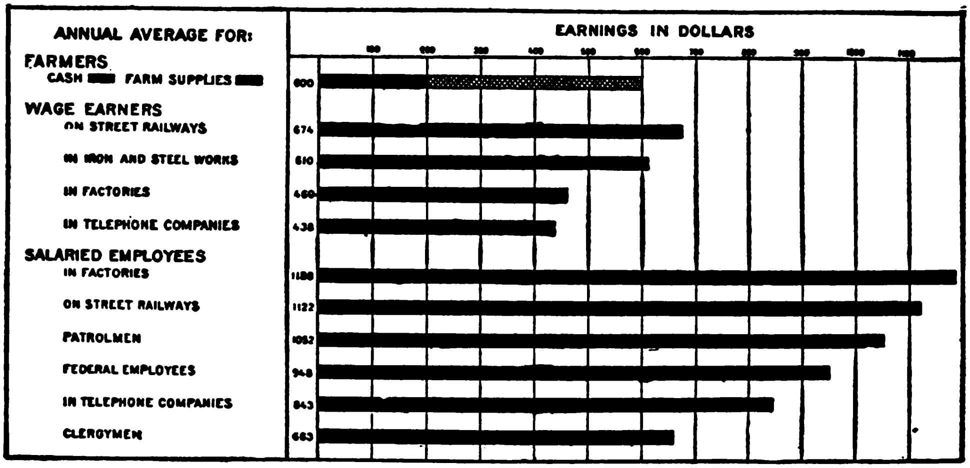



FIG. 32. A comparison of the earnings of different kinds of workers. It must be remembered that normally the cost of living is lower on the farm than in the city. (Farmers' Bulletin 746)

sell the articles he produces on the farm, the farmer would have to take into consideration the amount of interest for 6 years. The question of the rate of interest would be a much more important matter to him than to the baker, groceryman, or almost any other business man. To the farmer the question of whether or not he receives interest on his deposits, and the rate of interest he has to pay on the money he borrows, is extremely serious. His business is so hazardous and his rate of turnover so slow, that to him a loan is like making an investment. It will probably be a long time before the net income from the property will be sufficient to pay the debt, and by that time the property may have depreciated.

**The farmer and banker.** The farmer, then, should have only a general interest in the ordinary commercial stock bank, which loans current account deposits and, consequently, can make loans only for a short time; rather he should be interested in banks specially organized to suit his business. The land-owning farmer would then have sufficient capital to justify his receiving a long-time loan secured by mortgage at a reasonable rate of interest. Even farmers having no capital to speak of, who desired a personal loan, might be accommodated at a reasonable rate, if a special device were worked out making credit depend on a moral and a material basis. Persons without much capital can borrow, if they can but combine their material solvency, establish a moral guarantee, and take loans only for production purposes. This form of organization has, however, made but little progress in the United States.

The rate of interest the small farmer has to pay comes as a surprise even to the well-informed. In an investigation made in 1914 in an average corn-belt county in one of the leading middle-western states, it was found that the farm owners borrowing on mortgage a sum not exceeding $500, paid, including overhead charges, 11 per cent interest. The net rate of income made on each farm probably did not amount to one third of this rate.

**Some of the farmer's difficulties.** It is worth repeating that the income of the farmer is haphazard and too small, especially the income of the small farmer. The manufacturer can plan and run his business with more or less clockwise regularity. In addition to the worry of dissatisfied laborers and the difficulties of securing materials, such as machinery, repairs, fertilizer, livestock, etc., which correspond to the troubles besetting the manufacturer, the farmer is beset by another series of difficulties unknown and unsuspected by the city rural reformer. His business cannot be carried on like that of the manufacturer with clockwise regularity and precision. He has no assurance that his plans will work out. At one time his farm is beset by drought; at another by too much moisture; now by insect pests of one kind or another,

at another time by disease; and finally, there may be no satisfactory market for what he raises. The production of the stock and produce to be sold may have been going on for a number of years before they are finished and ready for sale. Drought in the plains states in 1917 caused thousands of cattle and hogs to be shipped to market before they were finished, to the financial loss of their owners. The Hessian fly ruined thousands of acres of wheat in 1916. Drought dried up the corn in some parts of the corn belt. In the northern part it was nipped by the frost, resulting in thousands of acres of soft corn. Cholera claimed thousands of hogs. Potatoes were almost a failure, due to lack of moisture; and in the fall and winter of 1915 the packers lowered the price of hogs and cattle to a point so far below the cost of production that nearly all the feeders lost money. From 1913 to 1917 a considerable portion of the corn belt was visited by floods, and the planting of much corn was in consequence so much delayed that it did not fully mature. A few years ago surveys were made of all the commercial apple orchards in one of the leading apple states of the union. Less than 7 per cent of them were considered financially successful; the remainder were losing money.

**Yields, theoretical and actual.** One of our leading agricultural colleges considers the following yields practical under favorable conditions as to weather and insect pests, if the best principles of farming are intelligently applied:

| | |
|---|---|
| Corn .......... | 80 bushels per acre |
| Oats .......... | 60 " " " |
| Wheat ........ | 40 " " " |
| Hay .......... | 3 tons " " |

The ten-year average in that state is:

| | |
|---|---|
| Corn ....... | 28.4 bushels per acre |
| Oats ....... | 24.4 " " " |
| Wheat ....... | 14.7 " " " |
| Hay ......... | 1.15 tons " " |

It is the opinion of the head of the department of agronomy in the same institution that within 25 years, with all the advancement that can reasonably be expected, the yield may be profitably increased to:

| | |
|---|---|
| Corn ........ | 35 bushels per acre |
| Oats ........ | 30 " " " |
| Wheat ........ | 20 " " " |
| Hay .......... | 1.5 tons " " |

Why can we not more nearly reach the theoretical normal? The question has already been answered: because of unsatisfactory weather conditions, pests, adverse market conditions, lack of capital, and other reasons. It should be remembered that in a great majority of cases the farmer both owns and manages his farm. How many workers in industrial plants could successfully manage their entire concerns? And what is more, farming cannot well be industrialized. Ignorance of these conditions gives the uninformed man a wrong notion as to great profits in farming.

In a recent issue, one of our city journals came out with the statement that the matter with the farmer is that he lacks organization, brains, and capital; that agriculture is conducted without system, without scientific management, and as a hit-and-miss, every-fellow-for-himself scramble, and that it ought to be handled in large, thoroughly organized units under incorporated companies. This is how the city public, also, often look at the business of farming. They mistakenly believe that it would be easy to industrialize it.

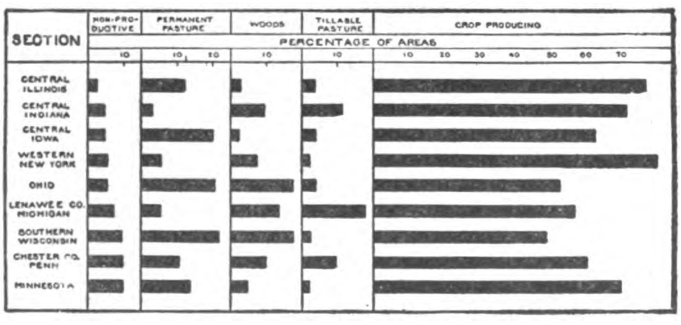



FIG. 33. Chart showing the average percentage of land on farms devoted to different uses in typical farming sections. The non-productive area is a dead load to be carried by the others. See also Fig. 15. (Kansas 20th Biennial Report.)

**Tendency toward medium-sized farm.** The tendency in the United States is toward the medium-sized farm, that is, a farm on which the head of the family, assisted by other members and an occasional hired man, does the greater part of the work, and which has enough land and

equipment to allow the most economical use of rather large machinery. In the grain region of the Middle West 160 to 400 acres best meet this condition. Where agriculture must necessarily be more intensive, a smaller amount of land will suffice; where it must be less intensive, more will be needed. It is a question not of the greatest yield per acre, but of the greatest yield per man, at least to the point at which the income of the farmer will allow a standard of living sufficient to permit him and his family to be efficient, self-respecting citizens of our republic. It may be truthfully said that, in very many instances, this is not the case. The farmer's school system, his church, his roads, his social life, the equipment of his home are not such as to prevent the ablest and best from deserting the country for the city. This does not alter the fact that, placed in the hands of competent men with adequate capital, the middle-sized farm shows itself superior in production to one of any other size. This is the tale the 1910 Census has to tell in regard to the matter: The very large farms and the farms under 100 acres, used for extensive farming, are decreasing in numbers. It is the farms above 100 acres and probably below 600 acres that are increasing in numbers. Though they are not properly capitalized, and though not run by men especially trained for that purpose, yet they are more efficient in production than larger farms.

This indicates that the attempt to industrialize farming would fail if the family-sized farm had a fair chance. The weakness of the medium-sized farm is on the business side, in which the large farm has the advantage. However, in the hands of competent men, through coöperation, the middle-sized farm should show itself most efficient both financially and socially. In other words, if it is to be given a fair trial, farming in the United States in the future must be carried on on the family-sized farm. This size of farm will also best enable the open country to perform its greatest function—the rearing of men for the entire United States. This improvement of the family-sized farm would also be best for the urban population. It would furnish them food at the lowest possible cost.

**The farmer's handicaps.** The farmer's capital and his income are not sufficient to enable him to play the important part marked out for him. He needs special organizations adapted to his peculiar wants, and so far there has been but a beginning in their development. The importance to the farmer of securing more capital is seen in the labor income he derives from the different amounts invested in his farm and its equipment. In central New York, according to Warren's "Farm Management," farmers with an investment of $2,000 or less receive, after allowing 5 per cent on the capital invested, a labor income of $192; with an investment of from $6,000 to $8,000 a labor income of $530; and with an investment of $15,000 or more, a labor income of $1,164. This labor income is due to a saving on, or an increased efficiency in, practically every item that goes to make up his capital, as the farm becomes larger, such as size of farm (not larger than family size), machinery, labor, buildings, etc. The average size of the farm in the United States for the production of staple crops is growing larger, and this is because it is more profitable. If the larger part of our farmers had more capital, they would earn a larger percentage on their investment. If they had proper credit institutions they could readily borrow on reasonable terms.

The fact that the farmer's income usually is not received in driblets may be an advantage. It should, and in many cases does, induce saving, and encourages him to have larger visions and to attempt to realize them.

**Farmers lack organization.** Farmers for the most part have not organized. They are still in the stage of autonomous producers, each one for himself.

Their condition shows this to be a losing game. The farmer must organize or become a peasant. What is the best form of organization? Experience has shown that coöperation (Chapter 6) is the most promising. The genuinely coöperative organization is democratic. It provides for the distribution of profits in proportion to the purchases or sales made or work done. There is a tremendous loss in rural efficiency from lack of organization among the farmers. His purchases are made at retail; his sales at wholesale. This is one reason for his unprosperous condition and isolation. The young farmer should be a leader in his neighborhood and, if possible, in his county and state. He should give liberally of his time and money to awaken other farmers, and should not rest contented until they are organized. The tremendous revolution in the methods of carrying on industrialized business has scarcely affected him in his own methods. In fact, the number of independent farmers in proportion to the population has scarcely changed. How could the more than 6,000,000 such farmers combine to form a monopoly capable of holding its own against the industrial monopolies confronting them? They have been unable to do it. Instead of being able to limit his products to the active demand, as do many industrial concerns, each farmer does his best to produce all he can.

The rise of material forces and machinery have not done for the farmer nearly so much as it has done for those in other lines of activities. How has he done as well as he has? It has been due to fortuitous circumstances. Modern science, the use of natural forces to drive machinery, have done so much more for the city; and the desire of most persons to live away from human isolation has made the city, to them, more attractive than the country. So, in spite of the fact that the surplus population has been reared in the country,

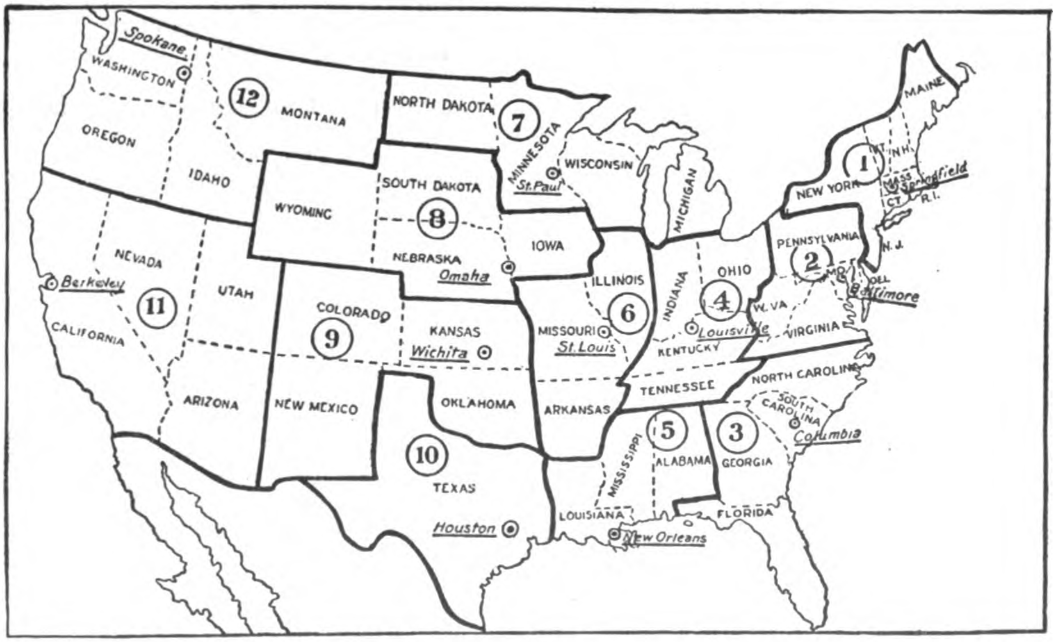



FIG. 34. Map showing the Federal Farm Loan Bank Districts and the location of the bank in each one. (From Bulletin of the Missouri State Board of Agriculture)

enough people have turned away from the environment of their childhood to go to the city to make the balance of the population as between the city and country such as to place the farmer in a much better position than he otherwise would have been.

Of course there is some surplus money in the country. Some farmers have outdistanced their neighbors in this respect. It is their duty to help build up the neighborhood in which they live, to use their influence and means to help their local institutions. The proper division and expenditure of the farmer's income is a difficult matter. His family should be supplied with necessary reading material. This is especially important where there is no local library. The books sold by subscription through traveling agents, and usually found on the shelves of the farmer's bookcase or on his table, are generally almost worthless and represent so much money thrown away. Many of the bulletins of the United States Department of Agriculture and from the colleges of agriculture, which directly pertain to his business, could be secured free of cost.

**Woman's life on farm a hard one.** The woman on the farm has been given too little consideration. Hers has too often been a life of drudgery. To bear and rear a family, doing the housework, washing, cooking (often for hired men), raising poultry, working in the garden, milking—all this is too much to expect of her, especially after some accumulation of property has been made. Too many think an investment of modern appliances in the home could earn no income. This is a short-sighted viewpoint. As soon as the financial condition of the family permits, modern plumbing, heating, and other appliances should be installed in the home. More contentment and better health should make this a paying investment. A coöperative laundry along with a coöperative creamery would relieve the farm woman of some of her most onerous duties. The reason farm machinery comes first is because it has been thought that the income came from this equipment. A reasonable expenditure in lightening and making more pleasant the work of the women on the farm would add very much to the well-being of the whole family.

Too little attention is given by farmers to politics of the right kind. The result is that there are but few farmers holding high positions in our government, even positions directly pertaining to farm matters. But few men in public life understand the farmers' problems.

**Cheap labor should be exposed.** Many farmers believe in cheap farm hands. This is a big mistake. On the family-sized farm the income comes from 2 sources: interest on the investment and labor income. Of these the latter is the larger and the more important. If labor is cheap, the farmer and his family, whose source of income comes mainly from their labor, receive a still smaller income. The farmer should oppose the immigration of cheap labor as he would the cholera. If successful, it means for him the ruin of the independent family-sized farm, and the incorporation in its stead of the large industrial farm.

The bank may be of the utmost use and importance to the farmer. That it does not properly meet his needs, there seems to be no reasonable doubt. To him the bank in general is a place to deposit money, without interest, awaiting investment; also, a place where he may obtain money on terms unsuited to his business needs. He takes little interest in the part his deposits play in enabling the bank to manufacture credit and thus loan back to him many times the amount of the bank's ready cash. The commercial banks are not suited to the farmer's needs, even from the standpoint of short loans on personal credit, and of course they are not available for mortgage loans. The security he is required to give is not suited to his condition, and so is hard, if not impossible, to get. The Federal Farm Loan Act does not offer much relief for short-time personal loans, it being designed to meet the need of farmers for long-time loans on farm lands.

**Federal Farm Loan Act.** The Federal Farm Loan Act, which was approved July 17, 1916, is discussed in Volume IV, Chapter 7, yet it is thought best to insert here the following explanatory paragraphs and table from Farm-

ers' Bulletin 792, "How the Federal Farm Loan Act Benefits the Farmer":

"In order to obtain a loan from a Federal land bank the borrower must agree to use the proceeds of the loan for one or more of certain objects specified in the act, namely, for the purchase of land for agricultural use; for equipment, fertilizers, and livestock for the land mortgaged; for buildings and other permanent improvements on said land; or, with certain limitations, for the payment of indebtedness. The borrower must furnish as security a first mortgage on farm land. The amount of the loan must not be less than $100 nor more than $10,000. The loan must not exceed 50 per cent of the appraised value of the farm land and 20 per cent of the value of the permanent improvements adequately insured. The borrower must be engaged, or about to be engaged, in the cultivation of the farm mortgaged. He will also be required, ordinarily, to become a member of a local national farm-loan association.

"The loans must be made for relatively long periods of time, running not less than 5 nor more than 40 years. Each loan must make provision for annual or semiannual payments on its principal, so calculated that the debt will be entirely paid at the end of the period. After a loan has run for 5 years, the borrower is given the option of paying any additional sum on the principal, in multiples of $25, on any interest date. The accompanying table shows the annual payments required on a loan of $1,000, running for a period of 20 years, with interest at 5, 5½, and 6 per cent."

*Amortization table for a loan of $1.000, payable in 20 annual installments, with interest at 5, 5½ and 6 per cent.*

| | Interest at 5 per cent | | | | Interest at 5½ per cent | | | | Interest at 6 per cent | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Completed years | Payment | Interest | Applied on principal | Principal still unpaid | Payment | Interest | Applied on principal | Principal still unpaid | Payment | Interest | Applied on principal | Principal still unpaid |
| 1..... | $80.24 | $50.00 | $30.24 | $969.76 | $83.68 | $55.00 | $28.68 | $971.32 | $87.18 | $60.00 | $27.18 | $972.82 |
| 2..... | 80.24 | 48.49 | 31.75 | 938.01 | 83.68 | 53.42 | 30.26 | 941.06 | 87.18 | 58.37 | 28.81 | 944.01 |
| 3..... | 80.24 | 46.90 | 33.34 | 904.67 | 83.68 | 51.76 | 31.92 | 909.14 | 87.18 | 56.64 | 30.54 | 913.47 |
| 4..... | 80.24 | 45.23 | 35.01 | 869.66 | 83.68 | 50.00 | 33.68 | 875.46 | 87.18 | 54.81 | 32.37 | 881.10 |
| 5..... | 80.24 | 43.48 | 36.76 | 832.90 | 83.68 | 48.15 | 35.53 | 839.93 | 87.18 | 52.87 | 34.31 | 846.79 |
| 6..... | 80.24 | 41.65 | 38.59 | 794.31 | 83.68 | 46.20 | 37.48 | 802.45 | 87.18 | 50.81 | 36.37 | 810.42 |
| 7..... | 80.24 | 39.72 | 40.52 | 753.79 | 83.68 | 44.13 | 39.55 | 762.90 | 87.18 | 48.63 | 38.55 | 771.87 |
| 8..... | 80.24 | 37.69 | 42.55 | 711.24 | 83.68 | 41.96 | 41.72 | 721.18 | 87.18 | 46.31 | 40.87 | 731.00 |
| 9..... | 80.24 | 35.56 | 44.68 | 666.56 | 83.68 | 39.66 | 44.02 | 677.16 | 87.18 | 43.86 | 43.32 | 687.68 |
| 10..... | 80.24 | 33.33 | 46.91 | 619.65 | 83.68 | 37.24 | 46.44 | 630.72 | 87.18 | 41.26 | 45.92 | 641.76 |
| 11..... | 80.24 | 30.98 | 49.26 | 570.39 | 83.68 | 34.69 | 48.99 | 581.73 | 87.18 | 38.51 | 48.67 | 593.09 |
| 12..... | 80.24 | 28.52 | 51.72 | 518.67 | 83.68 | 32.00 | 51.68 | 530.05 | 87.18 | 35.59 | 51.59 | 541.50 |
| 13..... | 80.24 | 25.93 | 54.31 | 464.36 | 83.68 | 29.15 | 54.53 | 475.52 | 87.18 | 32.49 | 54.69 | 486.81 |
| 14..... | 80.24 | 23.22 | 57.02 | 407.34 | 83.68 | 26.15 | 57.53 | 417.99 | 87.18 | 29.21 | 57.97 | 428.84 |
| 15..... | 80.24 | 20.37 | 59.87 | 347.47 | 83.68 | 22.99 | 60.69 | 357.30 | 87.18 | 25.73 | 61.45 | 367.39 |
| 16..... | 80.24 | 17.37 | 62.87 | 284.60 | 83.68 | 19.65 | 64.03 | 293.27 | 87.18 | 22.04 | 65.14 | 302.25 |
| 17..... | 80.24 | 14.23 | 66.01 | 218.59 | 83.68 | 16.13 | 67.55 | 225.72 | 87.18 | 18.14 | 69.04 | 233.21 |
| 18..... | 80.24 | 10.93 | 69.31 | 149.28 | 83.68 | 12.41 | 71.27 | 154.45 | 87.18 | 13.99 | 73.19 | 160.02 |
| 19..... | 80.24 | 7.46 | 72.78 | 76.50 | 83.68 | 8.49 | 75.19 | 79.26 | 87.18 | 9.60 | 77.58 | 82.44 |
| 20..... | 80.33 | 3.83 | 76.50 | ......... | 83.62 | 4.36 | 79.26 | ......... | 87.39 | 4.95 | 82.44 | ......... |
| Total | $1,604.89 | $604.89 | $1,000.00 | ......... | $1,673.54 | $673.54 | $1,000.00 | ......... | $1,743.81 | $743.81 | $1,000.00 | ......... |

By "amortization," as will be seen from a study of the table, is meant the process of reducing an indebtedness by installment payments through a period of years. In other words, the payments are such as to cover the interest and to settle a portion of the principal so that when the loan expires the debt is paid.

It is well for a farmer, whenever he has surplus money which he does not care to invest, or even when he borrows money, to deposit it in a local bank where he can draw on it. This deposit serves as a checking account for the depositor, and is safer and more convenient than money. The more deposits are resorted to, the higher will prices rise, to the benefit of the farmer, because his products will be higher and the money with which he pays his debts cheaper. Of two customers, one of whom deposits his money and credits as far as possible and the other does not, the former will be the favored customer of the bank. He is of more benefit both to the bank and to society: to the bank because on this deposit the bank can base loans, and to society because it will need less gold to do the work done by these deposits as checking accounts. If farmers are wise, they will take advantage of the profits in deposits and organize personal, credit banks suited to their own needs.

**The farmer and his surplus.** The farmer who appreciates the economy of owning a farm not so small as to be unprofitable can, instead of modernizing his plant for comfort or putting more money in equipment, use his surplus capital to enlarge it. Within certain limits this is the proper thing to do, but, when once he has acquired a farm of an area most profitable for the kind of farming in which he is engaged, the question arises what to do with his surplus. In this connection it seems quite certain that from lack of opportunity, desire, or capital, the average farmer and his family are not sufficiently acquainted with the information made available by the colleges of agriculture and other sources. The farmer has not as convenient and constant access to desirable reading matter, has not the social opportunities, does not play so important a part in politics, as the city man of the same relative financial position. From the nature of his occupation, requiring during the main working season long hours with physical exhaustion, there is the tendency for him not to become an habitual reader. Besides, his income in the past has been such as to make the most rigid economy necessary.

**The farmer and insurance.** The farmer may profitably expend some of his surplus in insurance. Insurance is based on a sound economic principle. The modern business man regards it as indispensable. So does the United States Government in connection with the troops; and the enlisted men in the United States Army will in the future be insured, the government and the men each contributing toward the premiums.

To the individual farmer the destruction of his cattle or hogs by disease or the destruction of his grain crop by hail is a matter of great moment. Property in the country is generally isolated. If animals become sick, the veterinarian is probably far away. In case of fire, there is no water system with which to fight it. If hog cholera or other contagious disease breaks out, seldom is the precaution taken of isolating the sick animals, nor is proper sanitation observed. In the case of hail, no human agency can prevent the disaster. The cost of inspecting and adjusting losses is relatively high. The result is a high rate of insurance both from the administrative and the actual loss side. To many companies farming business is unattractive, so that the main inducement to write such insurance is to make unusually attractive profits.

There is one recourse to the wideawake rural community and that is to form coöperative insurance organizations. (See Chapter 6.) Through such organizations the farmers can write their own insurance at a great saving in cost. That such companies are practical has been demonstrated. In some states nearly every county has an active fire and lightning coöperative insurance company for insuring farm buildings, livestock, and farm products. These companies are roughly federated into a state organization. It is not best that they cover too large a territory, for then close inspection for the prevention of fraud would be difficult and expensive. Insurance in such organizations costs the farmer about one third as much as in old-line companies. Cyclone insurance should cover a wider range of territory, because many cyclones extend over a considerable part of a county and the resulting loss would be too heavy if the insurance were too much restricted. Farmers should be encouraged to extend the coöperative plan so as to cover all kinds of risks mentioned above.

**Farmers should buy government bonds.** In times of crisis the government may be called upon to expend vastly more than its normal income. This deficit in income must be supplied by taxes or by borrowing. The proposition to be supplied by each is a matter concerning which expert opinion differs; but, whatever the proportion fixed upon by the government, each good citizen should do his part. The amount that each is to pay in

taxes is determined by law. This should be met honorably and cheerfully. If the emergency be pressing, borrowing may have to be resorted to. Bonds or other securities for loans must be issued and sold, which it is the duty of each citizen to purchase in proportion to his ability. It is no more the duty of the multimillionaire or the city capitalist to do his part than it is the duty of the ordinary farmer. Simply let each do all he can. A little reflection will enable one to see that these purchases cannot be made from invested capital. They must be made from ready money or from future savings.

**Rural conditions call for improvement.** The farmers on more than 6,000,000 farms are producing all they can with all their might. No combination or understanding to limit production or to control their marketing exists between them; it is a case of produce, produce with all their might, and do all they can to make their product immediately available for consumption. And under what discouraging natural environment must they produce! Limited by the conditions of space and time, rigid and hard to modify, life has to be created and growth promoted, and machinery can do but little except to improve the environment. Climate and soil are an unchanging basis, and the utilization of great natural forces and the use of machinery have done little save to accelerate the amount of production. Moreover, agriculture cannot well be industrialized, because the same laws as on industry do not always apply. How different are the conditions for the production and sale of industrial goods! There, by the use of unlimited power—steam, electricity, gas, and water—with production in many cases controlled, thus limiting the supply, an effective monopoly is built up which fixes the price to the consumer. Is it any wonder that if the city would-be rural reformer had his way, living in the open country would be made so unprofitable as to ruin the farmer? The farmer in the use of his money should take into consideration the principles of rural economics.

If the future citizen of the United States is to be either country-bred or only a few generations removed from it, it is fundamental to our future welfare that rural conditions be made as attractive as possible, so as to retain in the country that part of its population most suited to be the forebears of the future population, both rural and urban.

FIG. 35. The sodhouse was a common feature of early American farming conditions. We have progressed far; but there is still need for much improvement in rural and agricultural conditions as a whole.


**Fig. 36.** A good trade-mark is an invaluable asset in marketing. But it also sets a standard that must always be lived up to

# CHAPTER 4

# The Principles of Successful Marketing of Farm Products

*By* James Homer Collins, *Investigator in Market Surveys, Office of Markets, U. S. Department of Agriculture. He was born in California, but received his education in Iowa and in Arkansas where he graduated from the State College of Agriculture, having meanwhile spent his vacations and one full year on the farm. In 1913-14 he conducted orchard investigations for the Arkansas Experiment Station, making a special farm study of fruit production in the Ozark section. In 1914 he was appointed Scientific Assistant in Marketing and Distribution in the Office of Markets, advancing later to the position he now holds. His work has included market surveys in many of the principal metropolitan centers, investigations and demonstrations in producing areas during periods of crop movement, and administrative work in Washington. In connection with the National Telegraphic News Service on fruits and vegetables he has visited more than 35 states. He has also made special studies of market conditions in the tomato districts of Florida, the potato district of Eastern Oklahoma, the trucking districts of Mississippi, the fruit districts of Missouri, Arkansas, and the Far West, and the Salt River Valley in Arizona. He has prepared several official bulletins of the Federal Department of Agriculture as well as numerous special reports, articles, etc.*—Editor.

MARKETING is a phase of agriculture which is not well understood by the American farmer. In an age of specialization the farmer's business is developing along two very definite and distinct lines. Production is still the fundamental function, but the problem of disposing of his product is demanding an increasing amount of the grower's attention. He finds himself, in many cases, compelled to fill the dual rôle of producer and distributor, because his business is of such a nature that he cannot easily or economically delegate part of his duties to another. As might be expected, the commercial phase of his work has been subordinated, so far as his own activities are concerned. At this point the middleman has entered the field and, besides exercising the functions which are properly his, has appropriated many of the duties which the grower should perform for himself. There is at the present time a tendency on the part of progressive farmers to assume to a considerable extent those purely commercial duties which might reasonably be taken over by the actual producer. This tendency is regarded by many economists as the best of evidence that present readjustments will ultimately result in a return to the primary producer of a greater percentage of the gross receipts derived from the sale of farm products.

The most serious error of the American farmer is his failure to study in advance of planting time the commercial prospects for the crop he expects to grow. Heavy losses are sustained annually by producers who assume that a

Fig. 37. A crate of melons as received by the retailer. They will be hard to sell, and the farmer who packed them will not be asked for more.

ready demand will manifest itself at harvest time and who fail to make preliminary inquiries as to what the usual commercial history of the crop has been. The wise grower plants those crops (giving due heed to desirable varieties) that are staple on the market and sell readily even in the face of heavy production, and avoids heavy investments either of land or of money in commodities which have a limited demand, even though prevailing prices may be extraordinarily attractive. The farmer who achieves success is the one whose commodities are always salable and whose market is never entirely glutted.

It is manifestly impossible to cover in one brief chapter the entire field of farm marketing. There are, however, certain fundamentals which should be understood by the man who must dispose of the products of his farm; and the attempt will be made in the following paragraphs to cover those elementary facts about marketing with which every farmer should be conversant.

## Grading and Packing

Well-known or standard containers should always be used for products sold by the package. In most cases, such containers are the results of years of shipping and selling experience and are the types of package which experienced shippers have found to be most satisfactory under all conditions. The bushel basket, the standard barrel, the 4- and 6-basket crate, the "climax" basket, the apple box, and the 16-quart Delaware hamper are all excellent examples of satisfactory containers. They are, of course, not interchangeable, and the fruit grower who attempted to market extra fancy apples in bushel baskets instead of boxes or barrels would find the returns as disappointing as though he had attempted to introduce a radically new package. It is well to remember in packing goods for market that habit is difficult to overcome. Buyers usually regard with a skeptical eye any innovation either of commodity or of package. The shipper who expects to bill to a new market would do well to make careful preliminary inquiries (preferably of the firm or firms who will handle his goods) concerning the likes, dislikes, and peculiarities of the local trade. Most reliable firms are glad to advise with their shippers, because the selling risk is thus minimized and the returns are more likely to be satisfactory to all concerned. Some large houses are careful to advise shippers as to the best methods of packing, loading, and shipping, and find their return for this extra service in the greater volume of business which results.

**Container legislation.** Of late years, the agitation for standard containers has resulted in considerable legislation, both state and national. The provisions of these laws and regulations are known to but few farmers, and there are many instances of unintentional violation of the law. Growers who are in doubt about Federal laws and regulations should write to the Secretary of Agriculture, Washington, D. C., asking for specific information to fit their cases. The Dairy Commissioner or Food Commissioner or the Director of the State Agricultural Experiment Station can usually advise regarding state regulations.

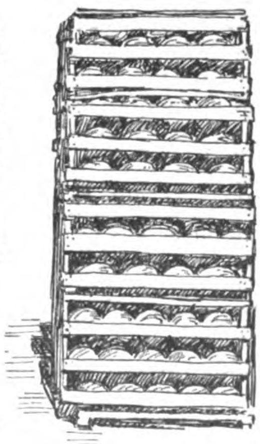


Fig. 38. Carefully sorted and well-packed melons which will bring good prices and stimulate more business.

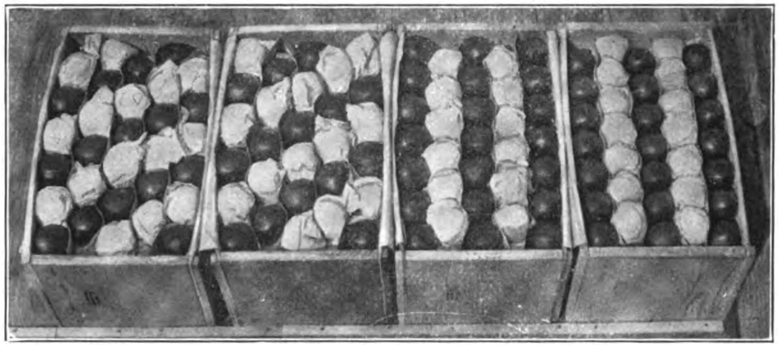
Plowing 20 acres of sodland per day. Extensive methods may mean smaller yields per acre, but they also mean a lower cost per unit of area and of production

To know the cost of a crop, one must keep an accurate record of the time spent upon it by each man and by each beast

MODERN FARMING AIMS ESPECIALLY AT THE REDUCTION OF LABOR CHARGES. IT ALSO INCLUDES IMPROVED MEANS FOR KEEPING TRACK OF THEM AND ALL OTHER ESSENTIAL FACTS


Get the habit of telling what you want and what you have to dispose of; it brings business


Whatever your style of package, make it attractive, uniform and fair—both legally and morally



High quality products and a high class market justify extra care and expense in packing and marketing

**One of the Commonest Causes of Farm Failure Has Been a Lack of Business Methods; Here is Where the Farmer Can Take a Lesson From His City Cousin**

The farmer whose goods are of superior quality, carefully graded, and properly packed never lacks for a market. A glutted market is disastrous chiefly to the shipper whose goods are indifferent in quality, appearance, and pack. The thoughtful farmer should remember one fact—the lower grades of farm produce are proportionately more affected by a general decline in prices than are the fancy grades. A general weakening in the tone of the market always manifests itself first in the movement of second-class commodities, and the divergence in price quotations between poor and high-class commodities is always more marked during periods of market depression. Quality products sell readily, even under the most adverse conditions. This fact is taken advantage of by shippers in certain districts where careful grading is almost universal. The apple growers of the Pacific Northwest have, by the application of rigid grading and packing rules, created a market for their fruit which is nearly distinct from the barrel apple market. Grading and standardization have been among the greatest influences in expanding the market for citrus fruits, and to-day the orange is as staple a commodity as the apple on the great metropolitan markets. Potato growers on the Eastern Shore of Virginia have established an enviable reputation for their output and have thus been enabled to place cars in markets as far west as Kansas City in the face of active competition from middle-western growers. In general, the expenditure of time and money necessary to raise the standard for farm products has returned to the growers many times the original investment.

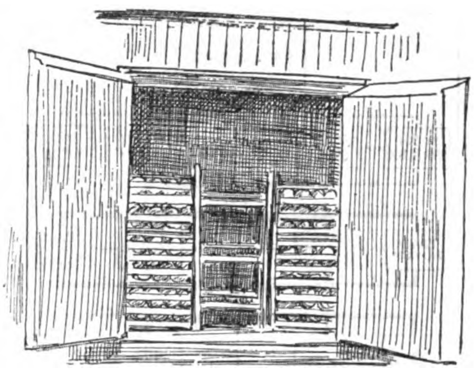


FIG. 39. Showing how to pack and brace crates of farm products in a freight car. Care must be used all the way from the farm to the consumer.

## Methods of Sale

**Consigning.** Consigning may be defined as that method of marketing farm products wherein the producer utilizes the services of a commission merchant in disposing of his produce paying therefor a definite percentage of the gross receipts. It is perhaps the most elementary form of selling produce through commercial trade channels, and because of its simplicity and availability is the usual resort of the small producer. The farmer who has no established trade connections or who has no local outlet for small quantities finds his only salvation in the commission method of sale.

Few farmers realize the absolute necessity of making an intelligent selection of the agent to whom they entrust their goods. To the grower who desires to exercise care, the first consideration, of course, is the business and moral responsibility of the commission man. The small shipper can often secure the names of reliable concerns from big carlot shippers in his vicinity. Local freight agents, also, are sometimes well informed and can be of assistance to the inexperienced shipper. The commercial rating of any dealer may be secured from publications issued by concerns which make a specialty of preparing such statements. While these commercial reports cannot, because of their very nature, answer the farmer's natural query, "What is the best commission house for me to use?," they are without doubt the most reliable source of information for the producer who has neither experience nor personal counsel.

One matter often overlooked by shippers is the difference in the character of business conducted by various commission firms in the same city. Most houses will handle all classes of produce, but specialize on certain commodities or on goods from certain districts. The dealer who makes a specialty of the apple trade will probably prove the most satisfactory agent to negotiate the sale of the farmer's apple crop, because he has developed special outlets for this type of fruit. The

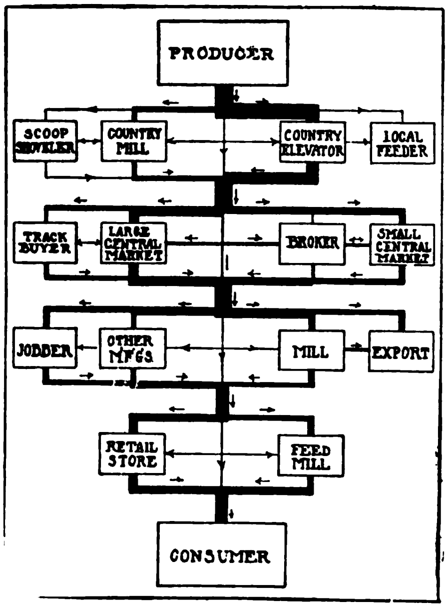



**Fig. 40.** Principal channels for distribution of grain and grain products. The comparative volume of trade through each is suggested by the width of the connecting lines. (U. S. Dept. of Agr. Bul. 558.)

house which finds its chief source of supply in the trucking districts of the South is apt to have special facilities for the disposal of such crops as lettuce, snap beans, tomatoes, celery, peppers, etc. Eggs, butter, poultry, and allied products should be shipped to firms who have developed this side of their business. The advertisements of most firms indicate their specialties and to this extent may serve as a partial guide to prospective shippers.

**Division of shipments among several dealers unwise.** The most common weakness of the small or occasional shipper is his tendency to divide his shipments among several dealers, or to change market representatives every season. He has a perfectly natural impulse to attempt to increase net returns by trying several selling agencies. It is safe to say that every "fly-by-night" concern organized for the purpose of exploiting the farmer has had its inception in the farmer's weakness for "swapping horses in mid-stream."

Many commission houses make a practice of keeping their regular shippers in touch with all prevailing market information. This information is of value to the farmer who discriminates in the choice of his representative and who is duly cautious about accepting information which may be biased by the self-interest of the commission man. The daily, semiweekly, or weekly quotation sheets issued by reliable distributors are often the best guide for the producer who has been unable to follow market conditions day by day. The commission man is also a good informant on questions relating to type and size of package to use, methods of grading, packing, loading, and time to ship.

Well in advance of arrival the shipper should advise the commission merchant of the date of shipment, grade and package, route and billing, so that arrangements may be made for the proper receipt and disposition of the goods. A day's delay in the yards of a big terminal market may mean the difference between profit and loss to the farmer. It is necessary that there be close business coöperation between the producer and his salesman at market. Such coöperation is often fostered by a personal visit to consuming centres. The ideas secured by such a visit will more than repay the expense of the trip.

Commission charges vary with different commodities, but are fairly uniform for the same product. On perishable fruits and vegetables the usual charge is 10 per cent of the sale price. The commission charge for selling livestock in carloads at the principal wholesale markets varies from $5 to $20 per car, the usual charge for cattle being about $12. Charges for other products vary with the value of the consignment or its perishability.

**F. o. b. selling and its limitations.** The abbreviation f. o. b. means literally "free on board." During the past 10 years the f. o. b. sale has been gaining rapidly in favor, its merits appealing so strongly to the small farmer in particular that he has come to regard other sales as makeshifts. The f. o. b. sale is known wherever farm products are sold and is extensively employed by producers in all parts of the United States.

In general there may be said to be two types of f. o. b. sale, namely: (1) f. o. b. for cash (rather uncommon), and (2) f. o. b. usual terms. The latter implies payment at time of delivery after inspection of the goods by the purchaser. "F. o. b. point of origin" and "f. o. b. New York" are phrases having a distinct meaning. The f. o. b. sale where payment is made and ownership passes at the time delivery is made on board cars at point of origin has come to be known as the "cash track sale" in contradistinction to the sale "f. o. b. usual terms," where payment is made at time of delivery at destination, although on the basis of a price quoted on board cars at origin. It will thus be seen that the sale "f. o. b. usual terms" is merely a contract for the purchase of goods on the basis of a price on board cars at origin, the sale not being completed until inspection and acceptance of goods by the purchaser at destination.

The cash track sale has several obvious advantages which commend it to the small grower in particular. The risk of loss or de-

terioration in transit are assumed by the buyer, negotiations are simple and personally conducted, and payment is made promptly and in cash. These conditions of sale are the ideal toward which many producers are striving, and the cash track sale is usually satisfactory to the small farmer.

Opponents of the f. o. b. usual terms sale claim that the buyer always has the benefit of the doubt, as he may accept goods on an advancing market and reject them on a declining one, the shipper taking the loss in either case. One of the most important farmers' coöperative associations in the United States, which markets a large part of the potato crop produced in an eastern state, makes most of its sales on an f. o. b. basis. On the other hand, a strong association which disposes of 70 per cent of the citrus output of a western state is opposed to the principle of the f. o. b. sale on the ground that it encourages speculation and hence is detrimental to the best interests of the grower. There can be but little doubt that, with a marketing organization constructed along the lines of the latter association, the grower will benefit by delivered sales.

**Contract sales.** There are two general types of contract which have to do with the marketing of farm products, namely: (1) the contract to market goods through some individual or corporation acting as agent for the grower, and (2) the contract to sell produce to some individual or corporation. Contracts between growers and selling agencies are common in all parts of the United States. All of the cantaloupe growers in California and Colorado, many of the apple growers of Colorado and the Pacific Northwest, and some strawberry growers in Florida arrange for the disposition of considerable quantities of their produce by selling agencies with whom contracts have been signed.

**The agency contract.** The agency contract (so called for lack of a more expressive term) is often based on advances of cash or the equivalent in crate, fertilizer, or spray material made by the selling agent to the grower. Many distributing companies owe a large part of their business to their ability to finance the grower at the time financial assistance is imperative. The life of this form of contract is usually for the period of indebtedness. The selling agency almost invariably reserves the right to exercise general supervision over the preparation of the product for market. Usually the goods are packed by the grower, sometimes by the selling agent, but in either case the agent reserves the right to reject products which, because of inferior pack or grade, he deems unsalable at market.

Most contracts call for the delivery of produce at the loading platform. The cost of loading into cars and bracing is sometimes borne by the grower and sometimes by the distributor, depending upon the selling charge. The agent may receive a commission (5 to 15, usually 10, per cent) or he may be paid a fixed sum per package.

Penalties for violation of contract by the grower vary with the contract. Certain western cantaloupe contracts require the grower to pay 25 per cent more for crate material if he sells any of his output except through his regular agent. Most contracts require the grower who "sells outside" to pay to his regularly constituted agent the full selling charge or commission on goods so sold as liquidated damages.

**The sale contract.** The best examples of what might be termed the "sale contract" are the various agreements between producers and canneries, pickle factories, sorghum mills, and the like by which the farmer agrees to sell directly to the second party of the contract, at a price and subject to stipulations set forth in the agreement. Most contracts of this nature specify in advance the price which will be paid. Others (such as those in vogue in the grape belt of western New York) obligate the purchaser to pay the highest prevailing market price for the class of goods delivered. Various conditions surrounding the industry determine which of these agreements will be entered into.

Marketing under contract possesses some very obvious advantages. Probably the most appealing of these advantages to the small grower is that he brings his crop to maturity secure in the knowledge that he has arranged for its sale in advance. Farm products marketed under contract usually come on a market prepared in advance to handle them. The importance of this fact can hardly be overestimated, since a very considerable portion of the loss annually sustained by inexperienced shippers is due to the indiscriminate billing of produce to markets not prepared to handle the same. Definite arrangements for selling perishables must usually be made by distributors in advance of the receipt of goods, and in this respect the grower who has contracted to deliver a certain quantity at a specified time has a very decided advantage at market. There is also usually some provision made for more careful grading and packing of a crop handled under contract than would be effected under a system of individual marketing.

The chief disadvantage of the contract system to the farmer whose output is well graded and packed for market is that he is obligated in advance to make a certain disposition of his goods, and for that reason may find it necessary to refuse more attractive offers at harvest time. Some contracts obligate the grower to purchase containers and other supplies from the selling agency at prices rather in advance of those which he might have to pay if he were free to purchase these supplies in the open market.

Analysis of most contracts now in effect, however, lead to the conclusion that under present methods of handling farm products, the contract is worthy of encouragement and development, and, when entered into in good faith by both parties, is usually successful where conditions make this system feasible.

**Sales in transit.** Reference is made to the sale of cars which have been rolled unsold from the shipping point, either as "tramp" cars, or billed to some diversion point. Shippers in many sections of the country regularly bill their cars in the general direction of the markets they expect to utilize and then communicate by wire with prospective buyers. Should the car be sold before it reaches the first diversion point, the necessary diversion orders are wired and the car diverted to the proper market. Should the shipper be unable to sell the car by wire within a reasonable time, he permits it to go through to the likeliest market in the general direction in which it is billed and instructs some commission firm or broker to handle the consignment for his (the shipper's) account. Vegetable and fruit shippers in Florida and other southeastern states are much given to rolling cars unsold in order to secure the benefit of any general rise in market prices which may occur subsequent to the time of shipment. In some instances cars of Florida tomatoes have been diverted as many as eight or nine times. It need hardly be said that this is an abuse of the diversion privilege which adds greatly to the cost of marketing. On the whole, however, sales in transit have proved reasonably satisfactory, especially during seasons when the f. o. b. demand has been inactive.

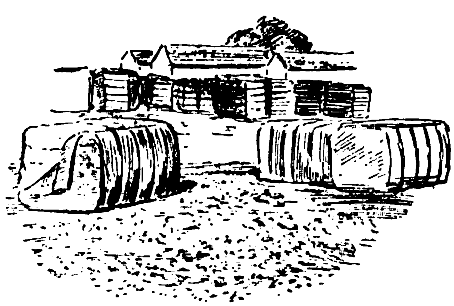


FIG. 41. Cotton left lying on the ground easily becomes damaged and loses value. Carelessness of this kind is a common cause of poor results in marketing.

**Shipping-point auctions.** Shippers in some districts, in order to stimulate a more active f. o. b. market in producing territory, have

organized local auctions. Buyers attend these daily auctions during the shipping season and compete for the offerings. This type of open local market has been attempted in the strawberry district of Louisiana, the peach territory in northern Ohio, and at various other points. It has proved reasonably successful where there existed honest competition between buyers, but where the latter are few in number there is a constant temptation informally to organize and agree on the maximum price which they will pay. The local auction has not received the attention it deserves; where started under the proper auspices and capably managed, it has inherent possibilities which should not be underestimated.

**Municipal markets.** Municipal retail markets have been utilized quite extensively by truck growers who live near many of our large cities. The municipal market has found its greatest development in the more thickly populated territory comprising the North Atlantic states. An appreciable proportion of the fruit and vegetable supply of such cities as Philadelphia, Baltimore, and Washington passes through the public market. The elaborate delivery and credit systems maintained by many retail stores have been responsible for the large business which these stores handle in direct competition with the municipal market. With the consuming public educated as to the economies to be effected by patronizing the public market, the municipal distributing centre would rapidly assume its rightful position as an important factor in reducing the high cost of living. Many municipalities have lately manifested a desire to give the public market an impartial trial, and the impetus thus given to the movement may result in appreciably lower living expenses in these cities. Capably managed, the public market has great possibilities.

**Parcel post and express shipments.** The quantity of farm products shipped from farm to market by parcel post or express does not constitute a very large percentage of the total food supply. Eggs, butter, fancy fruit, and similar products may be sent by parcel post from producer to consumer after preliminary business arrangements have been entered into. It has proved rather difficult for the average small farmer to establish satisfactory connections with city consumers, or, having established such connections, to collect on delivery of goods. In a limited way, however, some growers located near consuming centres have built up a satisfactory business direct with the consumer. Express companies handle even larger quantities of farm products. Many small towns depend for most of their fruit and vegetable supply on express shipments from nearby cities. The express business from farm to market is not quite so extensive, although the total annual movement assumes fairly large proportions.

**The fruit auction.** During the past five years a steadily increasing number of fruit and vegetable shippers of the United States have been awakening to the possibility of the wholesale auction method of sale. As a result the auction has been forging to the front as an important factor in the marketing of the fruit crop from certain districts. Beginning in a small way as an untried experiment, it has gradually become the sales medium for fruits whose aggregate value runs into the millions. Public auctions have been established in more than 20 of our metropolitan distributing centres and the list is growing yearly.

The fruit auction is conducted in exactly the same manner as any other public auction, the offerings being divided into lots and competed for by attending buyers. In many cities the auctions are financed by members of the local wholesale trade, individually or collectively. Some auctions have been financed by independent capital, and, to this extent, are presumably free from entangling alliances with the local wholesale trade.

No model form of organization has yet been evolved and no fruit auction can be regarded as a model of its kind on account of its form of organization. It is obvious that any auction dominated entirely by the local wholesale trade and operated solely in the interest of such individuals cannot give the shipper a proper representation at market. It is, however, only fair to the many high-class auctions financed by members of the trade to say that usually there is no attempt to give the buyer an undue advantage over the shipper.

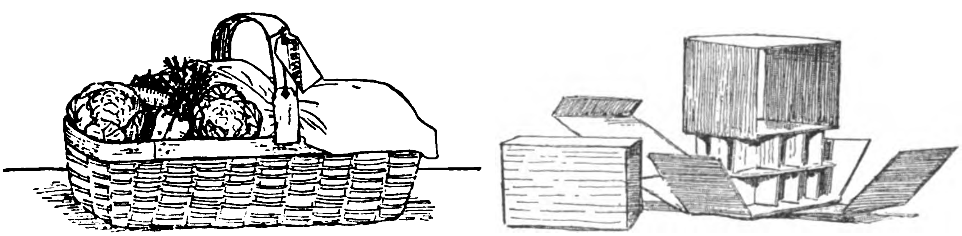


FIG. 42. Two suitable containers for the parcel-post shipping of farm products. Appearance is a very important factor in all direct producer-to-consumer marketing systems

Large quantities of citrus fruits are sold at auction each year. In fact the major portion of citrus fruits handled in cities which have auctions are sold in this way. Much of the deciduous fruit shipped to auction markets by growers living west of the Rocky Mountains is also sold through the auction. Each year finds larger quantities of such commodities as eastern apples, cantaloupes, peaches, etc. sold at auction.

Abuse of the auction. One thing which has militated against the success of the auction has been the tendency to use this sales medium as a general dumping ground for the disposal of goods which could not be sold at private sale. Eastern shippers are still too prone to regard the auction as a last resort. Without a doubt, however, the auction has been a very great benefit to shippers whose goods have reached overloaded markets, and it can be credited with doing as much in stimulating demand as any other sales medium in the country to-day.

The fact that the auction often offers the best outlet for fruit which is not salable through other media has worked to its disadvantage in many cases. Too many shippers have come to regard this sales agency as an outlet for fruit which is unsalable because of quality, condition, or the state of the market. There is the same tendency on the part of most buyers, and this attitude of mind causes them to feel that auction prices should not be so high as those which would be paid at private sale. The vigorous campaign which is now being waged by many auction companies may serve to educate shippers with respect to the true function of the auction. When this is thoroughly understood, the auction will doubtless take its rightful place as one of the most important media for the distribution of perishable foodstuffs.

Under present arrangements it is usually desirable for the shipper who expects to use the auction to bill his goods to some broker or other representative, who, in turn, places the fruit with the auction company. Under better business arrangements there will doubtless be an increased number of shippers who can bill their fruit through to the auction and thus save for themselves one selling commission. The fact that there is little provision for the shipper who bills through to the auction is one of the chief disadvantages of the present auction system.

The exponents of the auction have in some cases been overoptimistic. Their tendency to regard the auction as a panacea for all selling evils must be taken with a degree of conservatism. The auction is not a cure-all for marketing problems, but in its own way it bids fair to be one of the greatest agencies for good in the history of the fruit-selling industry. The ability of the auctioneer to place large quantities of perishable foodstuffs before groups of assembled buyers has been a mighty influence in expanding the market to care for products which under ordinary methods of sale would either show a loss to the grower or be absolutely unsalable. Students of marketing problems are expectantly watching the auction, and important developments may reasonably be expected in the near future. It is altogether conceivable that the producer of the future may come to realize more and more the possibilities of this method of sale.

## The Middleman

The term "middleman" is one which has been rather indiscriminately applied to the large class of dealers who act as intermediaries between the producer and the consumer. Strictly speaking, any agency which levies a toll on foodstuffs in the process of marketing might be considered as a middleman to that extent. However, custom has designated certain marketing agencies as true middlemen. For the purpose of this discussion, it will be necessary to classify only 5 types, namely: (1) the broker; (2) the commission man; (3) the wholesale carlot buyer; (4) the jobber; and (5) the retailer. The farmer's primary financial interest centres around the activities of these 5. It should not be understood, however, that these types are always distinct and separate entities. Thus the wholesale carlot buyer may act in the capacity of commission merchant for certain goods which have been consigned to him. The commission merchant may not receive all of his supplies on consignment and may find it necessary to purchase in small lots from wholesale carlot buyers and thus assume the functions of the jobber. As a matter of fact, many large wholesale firms, especially those dealing in fruits, vegetables, and other perishable commodities, simultaneously carry on the business of the commission man, the wholesale carlot buyer, and the jobber. It may perhaps be well to describe briefly the functions of each of these, despite the fact that their activities may overlap in actual practice.

**The broker.** The broker usually deals in carlots, acting merely as the shipper's agent in negotiating sales. He sells largely to the wholesale carlot buyer. In some instances brokers have expanded their business to include less than carlot sales, and these brokers are usually known as "split car" brokers. They receive cars billed to them and divide the contents among several buyers, thus apparently usurping the functions of the commission merchant. The primary difference, however, is that the broker makes all sales direct from the car and maintains no store for disposing of any of his wares. There have arisen during late years certain distributing companies whose functions are essentially those of the broker. These companies or exchanges maintain offices in many of the principal markets and in addition to offering to the grower the services of a first-class broker are enabled in addition to secure for him a wider distribution of his carlot shipments than he could expect from the broker whose business is centred in one city.

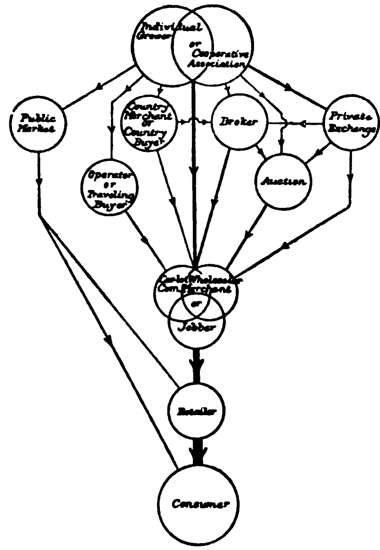



FIG. 43. Main channels of distribution for fruits and vegetables. Every additional agency between producer and consumer means an extra handling and an extra profit which must be added to the final cost without benefiting the grower. (U. S. Dept. of Agr. Bul. 267.)

The broker's services are utilized extensively by shippers who prefer not to consign and who have no established trade connections to whom they can sell direct. Since the broker acts merely as a selling agent, the shipper often stipulates that all sales must be subject to confirmation by wire. This is a wise precaution which permits the shipper to decline an offer which he feels detrimental to his interests.

The broker requires comparatively little capital, and for this reason irresponsible persons have often engaged in the business. Many of the most reliable brokers are heavily bonded. The shipper may recover on this bond any damage which results from carelessness or fraud on the part of the broker. The services rendered by the broker are very real ones, and the shipper who sells through a broker has for a reasonable fee secured the services of a skilled personal representative at market. He inspects cars upon arrival, negotiates their sale, and, where cars have been unjustifiably rejected, sees that the shipper receives justice. Selling through a broker involves an extra selling charge which some shippers do not care to assume. Others feel that economy demands that they be personally represented at market. The problem is one which each shipper must decide for himself. There can be no doubt, however, that the competent, honest broker will often save many times his fee to the shipper who needs representation at market.

**The commission merchant.** This distributor is used extensively by shippers who cannot sell f. o. b. and who have no other market connections. The commission house offers what is probably the best outlet for the small or occasional shipper who cannot furnish a dependable supply for direct sale. The business of the commission man, however, is not confined entirely to the class of business indicated above. His services are utilized by all classes of shippers in disposing of practically every agricultural commodity. The commission man comes nearer to being the universal distributor than do any of his business associates. Commission sales are regarded by some important shippers and shipping organizations as preferable to f. o. b. usual terms sales, since the grower benefits by any rise in price subsequent to shipment. This method of sale also obviates the danger of unjust rejections. Many growers are suspicious of commission men because of the bad name which has been given to the whole body of them by irresponsible firms who in the past have exploited the shipper. The dishonest

FIG. 44. Loading a wholesaler's wagon. The hauling charge is about two cents a bushel making the wholesaler's total charge about seven cents. (Wis. Bulletin 256.)

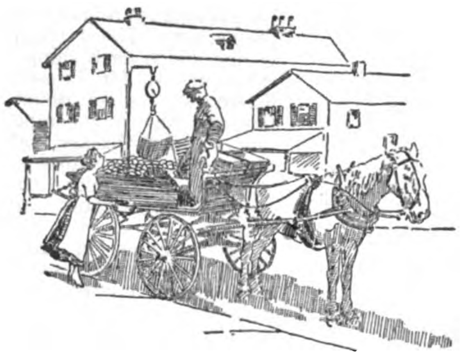


FIG. 45. The most direct system of marketing for the farmer located near his customers. Usually the city peddler is the last of a long line of middlemen.

firm, however, is invariably short-lived, and a shipper who deals with well-established, financially responsible concerns need have little fear. The commission method of sale is fundamentally sound, and the grower who satisfies himself as to the rating of his commission merchant will usually be assured of a good market connection.

**The wholesale carlot buyer.** This type of distributor purchases direct from the shipper as a rule, such purchases often being f. o. b. usual terms. Many of these firms have regular territory to which they look annually for their supplies. Most of the purchases are made from growers who are known to them. Some purchases are made by traveling buyers who pay cash at the shipping point. The advantages of the latter to the small shipper are very obvious. He may not secure the full market price, but cash at the time delivery is made to the car is a very important consideration. Wholesale carlot buyers handle a very large business annually. Some of these firms have injured their reputations in the past by purchasing f. o. b. usual terms and then declining the shipment on arrival because of a weaker market. The sentiment of the better class of trade is much against this practice, and the firm which earns a reputation as a "ready rejector" will soon find its source of supply seriously curtailed.

**The jobber.** These dealers secure much of their supply from the wholesale carlot buyer. Practically all of them also act in a commission capacity and solicit consignments from shippers. The farmer does not deal with the jobber direct, except in those cases where he deals with a jobbing firm which also does a commission business. The jobber is merely the intermediary between the carlot buyer and the retailer. There is some confusion in the use of the term "jobber," and in some cities the carlot buyer is referred to as a jobber. In most cities, however, the term clearly defines the agency which buys from the carlot receiver and sells to the retailer.

**The retailer.** An attractive business with the retailer has been built up by some producers who have very fancy stock in such quantity as to constitute a dependable supply. This outlet for the grower is, however, rather limited and is not susceptible of very great expansion. It has become nearly impossible for the unknown producer to sell large quantities direct to the retailer. The latter prefers to look for his supply to the wholesale trade with whom he can deal in a business way and upon whose supply he can depend. The retailer who "buys direct" may find the wholesale trade refusing to supply him and may find his credit suffering. It usually takes considerable time to establish satisfactory connections between the producer and the retailer, and this outlet must not be depended upon by the small grower who is unfamiliar with trade practices and methods.

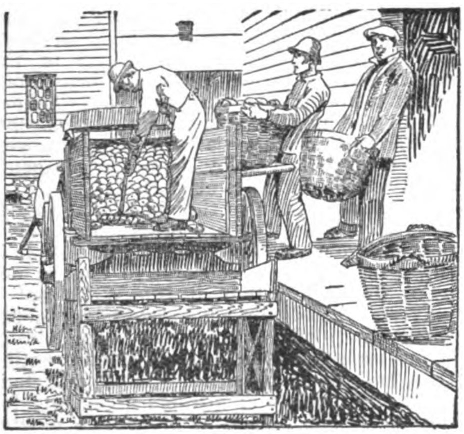
## Coöperative Organization

It is entirely outside of the scope of this paper to discuss the entire field of coöperation. The problems involved are so large and the activities so manifold that passing mention only can be given to the more salient features. Cooperation among producers is now in its infancy, yet the number of existing organizations would surprise many who are not thoroughly conversant with all the facts. Practically every state in the union can offer examples of successful coöperation. Extensive forms of agriculture, such as grain farming and dairying, afford the greatest number of examples. Farmers' coöperative grain elevators and creameries in the United States may be numbered by the thousands. Even cheese making, a side line of the dairy industry, is carried on by several hundred coöperative factories. It is almost impossible to estimate the total number of coöperative fruit, vegetable, and livestock marketing organizations that may be found wherever farm products are produced in large commercial quantities. While some of these organizations may not conform to prevalent ideas regarding the form which farmers' organizations should take, nevertheless the coöperative idea forms the basic structure.

**Why many farmers' associations fail.** The failure of so many farmers' associations each year is largely due to the fact that these bodies are hastily organized and that too often the organizers had no very clear conception of the problems with which they would be confronted. Successful organizations are almost invariably the result of careful planning on the part of a few leaders who have endeavoured to secure as much advice and assistance as possible prior to forming the associations. First and foremost the plan of organization must be suited to local conditions. Many communities have attempted to transplant bodily organization plans from some other district and adopt them without modification. Where conditions in the two sections are essentially different, such a plan has almost invariably resulted in failure. Other growers do not realize the absolute necessity for capable management and feel that most of their problems are solved when the organization has been finally effected. These growers usually find that their troubles are really only beginning and that the employment of a tactful, skillful, and experienced manager is the most economical plan to adopt.

A farmers' organization must be conducted upon business lines. The community which organizes for social activities as well as for marketing often finds that the social end of the organization prospers at the expense of the commercial end. The constitution and by-laws must set forth very clearly the relation between the member and the association. Where the member is closely bound to his organization by the terms of his agreement, the organization takes on a stability which it would not otherwise possess.

**Standard of output must be maintained.** No marketing organization can succeed for any great length of time whose output is not kept to a certain standard. Practically all of the large marketing organizations now in existence owe a large part of their commercial success to the well-graded, well-standardized character of their output. During the early period of its existence each organization should establish grades and standards which will be applicable to commodities handled through the association. An attempt should be made to adhere as closely as possible to these established standards, and the most rigid grading and packing rules should be followed. Some system of association inspection is practically necessary, as the individual member is seldom qualified to grade and inspect his own product.



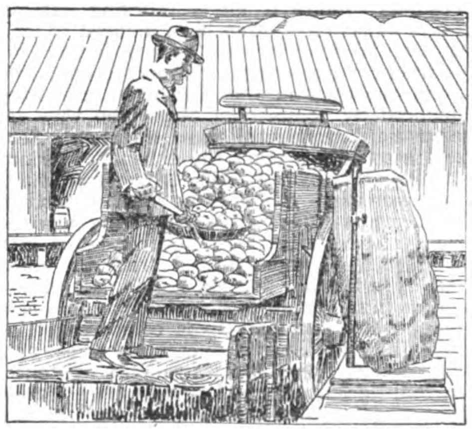


Fig. 46. Poor economy (*left*) and improved methods (*right*) at a potato warehouse. Where the work, as here, is intermittent the men are sure to waste time waiting around. Machinery would do better work and cost less when not busy. Even a bag holder, freeing one man, is a real time saver. (Wis. Bulletin 256.)

The loyalty of the individual members to the association is absolutely essential to success. Any organization whose members are disgruntled or lacking in coöperative spirit is almost sure to fail. The most capable selling machinery in existence could not work to highest efficiency if the shippers were not offering the fullest and most complete coöperation.

Nearly every new marketing association meets with the antagonism of those who have been profiting by the growers' previous lack of organization. Growers who organize must understand that efforts will be made to attack the association. A common method of attack is for the independent buyer to offer the association member more than can be secured through the association. Some organizations have met this attack by requiring the member to turn such bids over to the association to be filled from the member's goods. This enables the grower to secure the advantage of the higher price and at the same time gives to the association the credit for the sale.

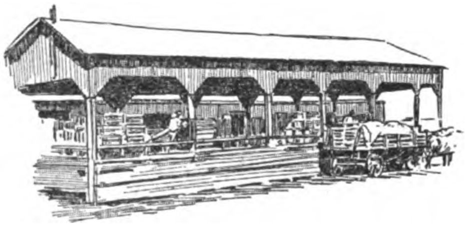


FIG. 47. A good fruit-shipping platform for a coöperative or community organization

**Financing of associations.** It is not possible to dwell at any length on the financing of farmers' organizations other than to indicate some of the sources from which funds are secured. Associations which conduct a consignment business usually need very little capital and are able, by the collection of membership fees and the accumulating of a small surplus from selling charges, to handle their business adequately. Other associations which have developed a large f. o. b. business require a larger working capital. Local banks have often been induced to lend substantial financial assistance to farmers organized for marketing. Farmers' coöperative grain elevators in the Northwest are often financed by commercial firms who thus secure the patronage of these elevators. Several associations meet the expenses incident to marketing by borrowing money from their own members. There is no ideal method of financing a coöperative marketing association. Local conditions must be taken into account and funds secured from the most readily available sources. The association which has organized along strictly business lines, whose membership is composed of influential, intelligent producers and whose output is large enough to warrant its existence, seldom lacks money for legitimate needs. The organization which has been hastily formed by inexperienced enthusiasts is the one which oftenest finds itself lacking the financial support which is indispensable.

**Benefits of coöperation.** The benefits of coöperation among producers are legion. A great deal of the standardization of farm products effected in certain districts is traceable to the efforts of local marketing associations. Association products are usually better graded, better packed, and shipped under more distinctive brands than are the products forwarded by individual shippers. The coöperative association has often been responsible for developing a more widespread demand for the products of certain districts. Thus the organized efforts of citrus growers during the past 20 years have placed the orange on a par with the apple as a staple everyday fruit. The demand has increased far beyond the expectations of early growers of this fruit. Growers through community action have been enabled to pool losses incurred by disastrous slumps in market prices, thus lightening the burden which would otherwise have fallen upon a few shippers. Financial backing for an established organization is much easier to secure than for the individual. Banks have loaned as much as $500,000 to apple-shipping associations in the Northwest, to finance the marketing of one season's crop. The individual grower cannot afford to employ a skilled marketing agent. In coöperation with his neighbors, however, he is enabled to employ high-salaried agents to protect his interests at market.

It will be seen from the above that the effects of organization are far-reaching. The benefits are so real and so tangible that it is surprising that the coöperative idea is not more widespread than it is. While not a universal remedy for all marketing troubles, coöperation offers the most economically sound basis for better agricultural marketing than has yet been devised. Each year finds a greater number of growers organizing for mutual benefit. There is probably a greater opportunity for all growers, both large and small, in coöperation than in any other plan which is universally applicable.

## Market Price Quotations

Market price information is now available to the producer from several important sources. The Bureau of Markets of the United States Department of Agriculture issues special market reports on fruits, vegetables, hay and grain, meat and livestock, honey, and other commodities which are being daily added to the list. Many of these reports are released daily, some weekly, and others once a month. They may be secured free of charge by any producer who indicates a need for the service. The principal trade papers, also, carry very comprehensive market reports covering the period between issues. Daily "price currents" are issued by companies operating in many of the principal markets. These price currents quote most of the agricultural commodities being offered for sale on the market. Most of the important daily papers devote space to market reports on produce, hay, grain, livestock, and cotton. Bulletins are issued periodically by many large commercial houses for distribution among patrons. A portion of the information contained in these house bulletins is often sent by wire to important shippers who deal with the house in question. It will thus be seen that the farmer who lacks price information is not alive to the opportunities along this line.

Most of these quotation sheets give jobbing prices, and, unless otherwise specified, the reader should understand that the jobbing price is meant. Some of these reports give a fairly wide range of price. This tendency to include prices on all sales has sometimes caused these reports to be very indefinite. The producer who sees apples quoted at from $2 to $5 per barrel is little the wiser for this information. Most of the information, however, is fairly understandable and concise enough to give shippers a very fair idea of prevailing prices. Many inexperienced shippers do not understand the true functions of the price quotation. They have a tendency to ship to the market quoting the highest prices, forgetting that extra freight charges may offset the higher prices. The net return is the only safe basis of comparison. If the shipper will deduct freight charges before comparing prices on different markets, he may conclude that the market nearer home offers him a better outlet than the one further away which may happen to be quoting higher prices.

Prices of hay, grain, livestock, and certain other staple commodities are not as a rule subject to violent price fluctuation within short periods. The fruit and vegetable shipper should remember that prices on perishables may drop almost to the vanishing point within so short a period as 24 hours. For this reason the price quotation should not be used by the shipper as an absolute guide to prospective prices. These quotation sheets, however, are of very great assistance to the shipper who desires general market information and who wishes to be informed regarding general conditions prevailing in the principal markets to which he may ship.

## Advertising

The nature of the farmer's business does not permit as extensive advertising as is employed by vendors of other utilities. The manufacturer or merchant who deals in nonperishable commodities has his advertising problem simplified by the fact that he is merchandising his wares the year round. The salesman who has a product which finds ready consumption throughout the entire year is better able to reap the cumulative effects of advertising. The farmer who usually has something to sell only during a short period each year finds it difficult to benefit materially from an advertising campaign. Grow-

FIG. 48. Field-sorting potatoes into three sizes. This results in a better-graded product and less handling later on.

ers, carlot shippers, and distributors are, however, just awakening to the possibilities of judicious publicity. One fruit growers' association in 1917 spent over $350,000 in advertising, and had plans for still more extensive campaigns to place its product before the eye of the consumer. Few associations and few growers can afford such expenditures, but may avail themselves in a more modest way of opportunities to interest purchasers in their wares. There are a number of openings for the farmer who deems it advisable to advertise. Many growers who are trying to sell direct to the consumer have found the circular to be a very good medium for publicity. The circular may be of the cheapest type and consist of one sheet printed on ordinary news-print paper, or it may be elaborated as an attractive, illustrated booklet. The latter is, of course, more expensive than the printed circular and can be used only where the value of the product is rather high.

Produce trade papers enjoy a very extensive circulation in trade circles and are the most important advertising media employed by commission houses or wholesale distributors. Space in these trade papers is frequently used by large carlot shippers who wish to attract the attention of wholesale buyers. Daily newspapers are often the means of stimulating demand in local markets. The producer who wishes to dispose of his product locally often finds a little space in the local newspaper to be a profitable investment.

**Posters and stickers.** Large posters are used to some extent in advertising the products of certain districts. Wholesale dealers often resort to this form of advertising when it is desired to stimulate demand for products which are meeting with indifferent sale. The poster has been used successfully by members of the wholesale trade in certain cities where campaigns have been inaugurated to clear the market of an oversupply of fruit.

Small stickers are often used by cantaloupe and watermelon shippers who wish to differentiate their product from the bulk of market offerings. The stickers attached direct to the melons are almost sure to be noticed by the consumer. Their use is increasing among producers who have high-class products for disposal.

The expense incident to agricultural advertising may vary greatly. The small producer will need to employ the cheapest medium, and practically every producer, no matter how small his output, can afford a small circular to be enclosed with his wares or mailed to his customers. Some large associations have found it profitable to secure expensive space in high-class periodicals. Naturally the individual grower can seldom employ such an expensive method of advertising. The most efficient and economical publicity campaigns are those waged by coöperative associations whose total output is sufficient to warrant the expense and whose membership is so large that the individual assessment is a minor consideration.

FIG. 49. Perishable products, such as fruit, need to be handled under shelter, but a simple packing shed can be easily and cheaply built in the field or orchard.

Very few growers realize the advertising value of an attractive or unique label or trademark. Some growers attribute their initial success to the attractiveness of their output. It will not pay to ship products of poor quality in fancy containers, but the grower who has a well-graded and standardized output will usually find it economical to add to its attractiveness by attaching thereto a neat, attractive label. A package which catches the eye of the consumer is much more salable than one which leaves a neutral impression on the mind of the passer-by.

## General Marketing Information for the Farmer

It should be definitely understood that there is now available to the farmer a very considerable fund of specific commercial information. Most of the perplexing problems of marketing have been at least partially investigated and the results placed on permanent record. Almost any reasonable query can now be answered, and the producer who does not familiarize himself with existent information is placing upon himself a severe handicap.

The grower should not hesitate to consult the United States Department of Agriculture and the specialists in his State College of Agriculture. The primary function of these organizations is to assist the farmer to a better knowledge of his industry. Should the regular printed bulletins not contain specific assistance, there should be no hesitation about writing for information to suit the problem at hand.

The industrial departments of many railroads are glad to advise with the shippers along their lines. In many instances these industrial or agricultural bureaus have saved thousands of dollars for shippers who were willing to follow instructions.

Commercial produce houses and trade papers depend for their existence on the prosperity of the producer. While biased by self-interest in some cases, the information disseminated by these factors is usually sound and reliable.

Too few of our farmers know how to ask for information. As a result, specific assistance cannot be given in many cases. First and foremost, the prospective shipper should advance his query early enough, so that he may have time to take advantage of the requested advice. Then, too, he should be specific. If the informant does not have all the facts in the case, he must either fail to answer or risk giving the wrong reply. Lastly, the farmer should not ask for information which he knows can be merely conjectural, or at least, if he does ask for it, he should give to it its true valuation.

## Market Preferences

Persons experienced in fruit and produce marketing have long since recognized the fact that cities, like individuals, may have pronounced peculiarities with respect to a food supply. Undoubtedly market preferences play a very important part in fruit and produce marketing. Big distributors, doing an interstate business, recognize this fact and cater to the likes and dislikes of consuming centres. The producer may do likewise where he has a clear understanding of the subject. This understanding must in turn rest on a knowledge of the reason why one market will readily pay high prices for a commodity which will find an indifferent demand in another city 100 miles away.

## MARKET PREFERENCES

| City | Apples | Eggs | Meats | Vegetables |
|---|---|---|---|---|
| New York........ | Red color. All good varieties. Medium to large sizes | White | Good demand for all grades of lamb and beef | All kinds sell well. Highest prices for extra fancy and out-of-season products. |
| Chicago.......... | Red color. All good varieties. Medium size | Either color | Heavy demand for cheaper cuts | Good demand for all kinds; less active on out-of-season products. |
| Boston........... | Red color. Best varieties only. Medium to large | Brown | Good for spring lamb and better beef and pork cuts | High prices for out-of-season and extra fancy products. |
| Pittsburgh........ | Red color preferred, but excellent for Grimes. All good varieties. Medium size | White as a rule | Good demand for ordinary cuts of beef and mutton | Good general market. Active demand for all classes of vegetables. |
| St. Louis......... | Red color. Ordinary varieties sell well, notably Ben Davis. Medium to small | Either color | Same as Pittsburgh | Good demand for staples, but will not pay high prices for out-of-season goods. |
| Kansas City...... | Red color, but Grimes sell well. Most good varieties. Medium to small sizes | Brown | Demand for fairly good cuts | Stronger than St. Louis on high-priced products, but fairly limited demand for all except staples. |
| Minneapolis...... | Red color. Excellent Jonathan market. Medium to large | Brown | Active demand for good cuts | Fairly good for fancy and out-of-season products. |
| Cincinnati........ | Any color. Takes some indifferent varieties. Medium to small sizes | Either color | Lower grade or cheaper cuts demanded | Good for medium prices and staple products only. |
| Philadelphia...... | Red color. Especially good for Staymans, Jonathans, and Winesaps. Medium | White as a rule | Demand good for good cuts | Fairly active on fancy stock. |
| Washington....... | Red color, but also good for green and yellow apples. Good varieties only. Large | White | Same as Philadelphia, but more active for more fancy stock | Good demand for fancy and out-of-season products. |

Factors determining market likes and dislikes are: (*a*) popular habit; (*b*) character and class of local produce firms; (*c*) type of city and population; (*d*) business affiliations of local produce houses; and (*e*) prevailing seasonal prices.

The early source of supply has had a decided influence. Cities which formerly depended largely on territory producing extra fancy fruit have become accustomed to this quality and utilized much of it in spite of high prices.

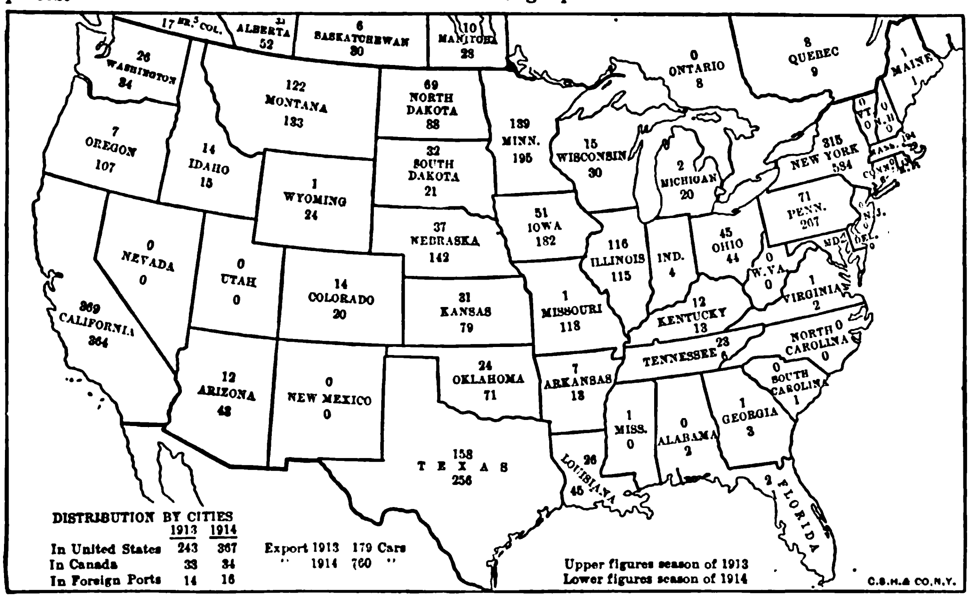



Fig. 50. Efficient carload distribution of apples as practised by a coöperative organization in the Northwest.

Habit is difficult to change, and those markets which early in their history developed a liking for certain classes of produce still show a marked preference for these grades or varieties.

Turning to a consideration of the type of distributing firms in various markets, we are confronted with the fact that the average producer is inadequately informed as to the character of the men who sell his produce. The public is much given to unquestioningly buying whatever is constantly displayed before them. The housewife too often accepts the judgment of the retailer, whether he be grocer, huckster, or fruit-stand man. The retailer in turn buys what he thinks will sell best, and thus the decision of the grocer or huckster helps to determine the character of the produce which will move in greatest quantity. If the retailer underestimates the quantity of extra fancy fruit which his customers may be induced to buy, the wholesaler will find little demand for the better grades. If the retailer finds that his customers desire only certain varieties, he will regulate his purchases accordingly. Soon the grower begins to realize that the returns from certain markets on certain classes of produce are uniformly unsatisfactory, and he begins to look elsewhere for an outlet for these commodities. The mental processes of the retailer may thus be said to be one of the primary reasons for market preferences. That this reasoning may in many instances be faulty or ill-advised is only to be expected. Many of the unexplained oddities of certain markets may be traced back to this foundation.

**Causes of market preferences.** Another basic cause of market preferences may be found in the fact that cities differ as greatly as individuals with respect to character and type. Most producers of perishable commodities know that certain cities are "cheap" markets, while others will take large quantities of the better grades and varieties. This, of course, is very fortunate, since there is an outlet for all classes of fruit. Markets which normally care for the cheaper grades and varieties usually pay more satisfactory prices for these grades than are obtainable in cities which demand the best. The apple growers of the Ozarks have thus learned to roll most of their Ganos, Yorks, and Ben Davises to Texas markets, and to place their finest varieties in northern cities. Shippers in the Pacific Northwest, whose fruit is packed and graded under rigid rules, bill an appreciable portion to points as distant as New York City and Boston in order to place their fruit on a fancy market. For the purpose of this discussion, we may make a tentative division of American markets into three general classes: (1) Manufacturing cities; (2) cities which are banking and distributing centres and have a wide diversity of interests; (3) cosmopolitan cities which, because of their great size, embody all the characteristics of smaller places. Manufacturing towns may in turn be subdivided into those employing a relatively high percentage of skilled labor and those whose industries are served by a large army of lower paid employees. Detroit and Pittsburgh are cities having a comparatively highly paid and prosperous laboring class, and this condition is partially reflected in the quality of produce demanded in these cities. Both consume large quantities of foodstuffs, and both are good markets for fancy, well-graded farm products. The number of highly paid workers is not so great in either Cincinnati or St. Louis, and the predominance of the poorer working class manifests itself in the tone of the market. These cities utilize large quantities of products which might not sell to advantage on more fancy markets, and they pay therefor a price which compares favorably with prices received for better produce in other cities.

FIG. 51. Hand sorting potatoes at a reloading station near the city. Much labor and expense could be saved by careful sorting and grading at the producing point, as in Fig. 48 (Wis. Bulletin 256.)

Boston, Cleveland, and Kansas City are cities which have a multiplicity of commercial interests. Cities of this class are usually fancy markets.

Certain markets, because of their great size, do not come entirely within either category. They consume large quantities of all grades and varieties, and their preferences do not have quite the significance which attaches to the likes and dislikes of smaller consuming centres. New York, Chicago, and Philadelphia are cosmopolitan in character and are used freely by shippers of all commodities. They are not exempt from the peculiarities of other markets, but their oddities are often lost in the ever-changing conditions obtaining in such cities.

In concluding a classification of different types of markets, it may be stated that one rule applies to all. Those cities having a native-born American population usually demand the better grades and varieties of farm products. Cities in which the foreign element is prominent prefer, as a rule, the

Fig. 52. Samples of cull potatoes sorted out at a reloading station (Fig. 51). Someone paid the freight on this waste material and the price of the edible stock will have to be increased to make up for it. (Wis. Bulletin 256.)

cheaper grades and are willing to pay fair prices for products which are nearly unsalable in the fancier markets.

**"Fancy" markets.** Trade arrangements in many cities have a decided influence on the development of market peculiarities. The wholesale produce business in many of our smaller markets is largely controlled by one or two local firms. These in turn have trade connections in producing areas, and the character of these connections helps to determine what shall be offered for sale in greatest quantities. Markets whose principal distributors look for their supply to districts well known for their output of fancy fruit soon become accustomed to this class of fruit and are known as "fancy" markets. Big distributors in other cities find their most desirable connections in districts producing less fancy products and their market gradually learns to consume the cheaper varieties and grades and becomes known as a cheap market. This classification is not intended as a reflection on the cheaper market nor on the people who purchase on this market. It is necessary to realize that only a small percentage of the farm products of this country can be classed as extra fancy. If it were not for the preference of some big distributing centres for the lower and cheaper grades, it is to be feared that the producer would more often find himself with a balance on the wrong side.

It is both difficult and unreasonable to divide American markets into arbitrary divisions and state that certain markets will take only certain varieties while others demand something entirely different. Market preferences are not quite so pronounced in actual practice. As a rule any of the larger distributing centres will handle practically everything that is marketable. It is distinctly unsafe to decide that only certain markets will take certain varieties or grades. An assumption of this kind may close some very satisfactory outlets for farm products. The importance of placing products on those markets which are best fitted to handle the same can hardly be overestimated; but, in the light of present knowledge, it is not safe to draw hard and fast conclusions. Market preferences in many cases have been established on an unscientific basis and are too often the result of habit or accident. It is a regrettable fact that these peculiarities have developed to their present importance. If this development is not arrested, the producer of the future may need a guide book in looking for a market. The remedy for these conditions lies in educating the consuming public to a realization of the fact that they are depriving themselves of many of those things which make for better living.

The table on page 66 has been prepared as a brief index of some of the preferences which now exist in certain of our more important markets. It should be understood that this table does not profess to be a complete guide for shippers using these markets. The fact that red apples are preferred by practically all American markets does not mean that many of these cities are not excellent markets for the disposal of yellow or green varieties. As a matter of fact, the better light-colored apples, such as Grimes and Greening, find a ready sale on practically every market in the United States. The table, however, does indicate certain facts regarding the special preferences of these cities which may assist growers in looking for satisfactory outlets.

FIG. 53. Tenant houses on a large, successful dairy farm. Clean, well-built, comfortable quarters induce help to stay in one place and make their work count

# CHAPTER 5

# Farm Owners, Farm Tenants, Farm Employees, and the Relations Between Them

*By* H. C. TAYLOR, *Chief, Office of Farm Management, U. S. Department of Agriculture, and formerly Professor of Agricultural Economics in the University of Wisconsin, who has made a special study of the relations between those who own farms, those who rent them, and those who work upon them under varying arrangements as to payments and profits. One man may think of farm tenancy as one of the greatest and most difficult of our rural problems; another may see it as a great opportunity for the ambitious young farmer of limited means. Depending upon the degree to which, and the way in which, it is developed, both may be partly right and partly wrong. So, too, with the question of long- or short-term leases, the rights of the owner in relation to the duties of the manager, etc. Every such problem is difficult and ever different because it deals with human factors and personalities. But at the bottom are certain truths and principles, and it is of these that Professor Taylor writes.*—EDITOR.

## Landownership on the Part of Farmers

**THE advantages of ownership.** To own the farm on which he lives and works is not only a source of great satisfaction to the farmer, but it stimulates the kind of farming which, in the long run, is most desirable socially and most profitable to the individual.

Ownership is important for a great many reasons, of which the following seven may be enumerated here:

(1) It takes time for one to become acquainted with his neighbors and to establish mutually helpful relations with them. Without the goodwill of the neighborhood, it is difficult to organize a crew for threshing grain, cutting silage, or any other job requiring a large crew of men for a short time.

(2) It takes time to establish credit relations and to learn how to buy and sell. Credit is based upon known character and ability. The man who must move from place to place may have these qualities and yet have little credit, because he has not had time to establish this fact in the minds of the business men of the community. It also takes time for one to establish a reputation for producing goods of high quality, for which top prices may be paid without fear that less obvious qualities may be lacking.

(3) Another advantage of permanency of tenure is thorough acquaintance

with the soil. Different soils require different management; and only by close acquaintance with them can one know how to treat them so as to secure the best results. What crops have been grown on each field, what fertilizers have been applied and when, are facts that must be known as a basis for planning the cropping system and the tillage methods for the years to come; and these facts only the permanent operator can always know.

(4) The goodwill of the soil is as important to the farmer as the goodwill of his neighbours. It is only by right treatment through a series of years that the soil is brought into good tilth and becomes well supplied with organic matter stocked with the bacteria which directly or indirectly prepare the food for the plants. Without permanent interest in the soil, the farmer may plow the land too wet, and thus break down the flocculency of the clay particles in the soil, reducing materially the annual crops; he may leave the cattle on the fields when the ground is wet and produce the same effect; or he may fail to destroy the scattering weeds in the cornfield, which will have but slight effect upon the present crop, but which will mature thousands of seeds every one of which will do its best to occupy the land and defeat the farmer in his efforts the next year. *Good farming is cumulative;* hence permanency of occupation is essential to the best success. Once the soil is in good tilth and free from weeds, less labor is required per acre, one man can operate more acres, and the yields per acre are larger. Good field culture is usually the result not of more labor, but of *good management and high quality of labor on the same land for a long period.* It is generally believed that ownership alone gives the permanence of tenure which justifies the farmer in introducing the best types of field management.

(5) The effect of ownership is even more obvious when farm buildings and fences are considered. The attitude of mind of the owner toward these semipermanent improvements determines their rate of depreciation. A nail driven in the right place at the right time often saves a barn door from ruin; a little paint applied by the farmer's hand makes the barns last longer and look 50 per cent better. The amount of labor required to keep the buildings and fences in repair is, of course, considerable; but it can be done at times when field or livestock work is making light demands upon time, and is thus not subtracted from the time which may be employed in the directly productive enterprises of the farm. Without the stimulus of property rights in these buildings, etc., and without permanence of tenure, few men are disposed to use their available time in caring for these improvements.

(6) In the livestock districts, the building up of a herd is a task which requires long-continued effort. It might be possible to succeed in building up a dairy herd of high quality without the permanence of tenure which is se-

FIG. 54. The pride of ownership reflects itself clearly in the type and upkeep of farm buildings. The man who owns a home and expects to leave it to his children has reason enough to make and keep it comfortable and attractive

cured by ownership, but it is seldom done in this country. The farmer who moves from farm to farm can take his cattle with him, but he cannot be sure of proper equipments for caring for them. This uncertainty discourages the long-time policy required in the successful breeding of livestock.

(7) Another advantage of owning land is the effect it has upon the accumulation of wealth by the farmer. The land is a safe savings bank, one from which the investor draws a return in money and in direct satisfaction. It is the desire to rise to the position of a free owner of a farm that stimulates the thrift which makes farmers the greatest of all working people to accumulate wealth.

**MEANS OF ACQUIRING LANDOWNERSHIP. Free land.** The relative importance of the various methods of securing land changes as a nation grows older. In the past, when government land could be had for the asking, it was easy for anyone willing to undergo the hardships of pioneer life to secure property rights in land. This has had an important influence upon the farmers of the United States. But in these days free land is of vanishing importance, and other methods of acquiring land are becoming more important.

**Gift and inheritance.** Many young farmers are so fortunate as to have parents or other relatives give them farms. It is a matter of common observation in the United States that farmers who are able often assist their sons in buying land. Often the home farm is greatly enlarged by the purchase of adjoining or nearby land during the period when the boys are helping operate the farm, and then, when one by one the boys are ready to farm on their own account, the process of division begins, or a new purchase of land is made and turned over to the member of the family ready to establish a home. What gift begins, inheritance completes; and in these 2 ways vast sums of wealth pass from generation to generation.

Unfortunately, the influence of gift and inheritance is greatly limited by the movement from country to city. This movement carries vast sums of farm-earned money to the cities. A farmer and his family move to the city. The farm is sold. The entire price must be earned, saved, and transferred to the city man's account in order to put the ownership of this land again in the name of the one who cultivates it. This movement has been very rapid in recent years and has been a large factor in the decline of the number of landowning farmers.

As a general rule, the greater the amount of land and other forms of wealth acquired by one generation and transmitted to the farmers of the next, and the more evenly this wealth is distributed, the greater the ease with which the ownership of land may be acquired by the succeeding generations of farmers. But the larger the percentage of each generation which seeks city occupations, the greater the amount of wealth which will be

FIG. 55. Tenancy—especially short-term tenancy—offers little chance and less incentive to beautify the home. Too many houses on rented farms are not kept up because they are not worth keeping up.

drawn from agriculture into other industries by gift and inheritance, and the smaller the part which inheritance will play in the acquisition of landownership.

**Savings as a means of acquiring land.** Prices of farm products tend to be such that the less efficient farmer can get a living from his industry. Where and when this is true, all the more efficient men who produce at a lower cost and sell at the same price secure a profit and are able to earn an income beyond what they feel obliged to spend upon their living, from which they can save money and invest it in land. The farm surveys which have been made in recent years show a wide range in the savable incomes which farmers receive. The wider the range of efficiency of farmers, the more important will profits become as a source of savings. The more nearly farmers are equally efficient, the more nearly will they as a class spend their incomes, and the smaller will be the savings available for buying land. Education brings out differences, ignorance reduces men to a common level; hence, education is a means of promoting profits in agriculture and of maintaining the landowning farmer.

**Credit.** A good credit system promotes landownership among farmers, by enabling them to buy land before they have the full purchase price. A good credit system should provide the young farmer with a profitable and safe investment for his savings prior to the date when he is ready to buy land, and, later, loan him funds within safe limits when the purchase is finally made. The third important consideration in a land credit system is the provision for a long-time period in which to wipe off the debt and a gradual proc-

ess of repayments. These 3 considerations are provided for in the present Federal law, which, with minor improvements which experience will doubtless indicate, will help to put the American farmer in a safe position when borrowing money on land. The difficulty in the past has been that the borrower was too much at the mercy of the lender. The new system eliminates the personal factor, and standardizes the farm-loan business to the benefit, it is hoped, of all concerned. In Germany, where a similar system of land credits has long been in use, landownership on the part of farmers is more common than in the United States, though indebtedness is much greater, which implies that a good credit system reduces tenancy and promotes ownership among farmers.

## Farm Renting

Many a young farmer who owns no land, and who would otherwise be required to remain in the employ of another farmer, finds it highly advantageous to invest his savings in the equipment necessary to operate a farm and to secure the use of a farm under a lease. This gives the young man a chance to gain, and to realize upon his ability as a manager as well as upon his skill as a workman. This enables him also to marry at an earlier age with a chance to rise gradually to the position where he can buy a farm, whereas the married hired man has little chance to rise. Experience proves tenancy to be an important stepping-stone to a better condition in most parts of the United States. Many tenants benefit by the advice of wise and helpful landlords.

In comparison with landownership, the tenancy system has its disadvantages, the most important of which are uncertain tenure, lack of incentive to take care of the soil, buildings, etc., which are noted under the advantages of ownership. Where compensation for unexhausted improvements is provided, as in England, these evils are largely overcome; but the fact of tenancy implies a man too short of funds to own the physical basis of his industry; and the one satisfactory system is landownership, toward which nearly all tenants in the United States are striving. While many landlords are helpful to their tenants, others are suspicious, fretful, bickering, stingy, ignorant men who are a drag on the energies of the tenant.

**FORMS OF TENANCY. The short-term lease.** This form of lease is very common in the United States, a vast number of farms being let for one year at a time. Many farms are let for terms of from 3 to 5 years, but longer terms are rare. It often happens that the tenant who has a contract for 1 year only will remain on the same farm for a long series of years. In this case, he comes to know the farm; but, even then, he has not the incentive to lay out his energy in improving the tilth of the soil and destroying the weeds with a view to less work and better crops in future years. If the long-time point of view is to be introduced into the mind of the short-term tenant, he must be promised continuous possession so long as he farms in a satisfactory manner, and, in addition, in case he leaves the farm, compensation for improvements which he has made and has not had time to realize upon. This is the way in which the "year-to-year" tenancies have been made tolerable in England.

**The long-term lease.** This lease, extending over a period of 19 or 21 years, has been looked upon as a means of giving a permanency of tenure which will stimulate good farming. In England, 100 years ago, the long lease was widely heralded as the one condition of intensive farming; but experience has resulted in the abandonment of the long lease in favour of year-to-year tenancies *with compensation for unexhausted improvements and payment to the tenant for disturbance, in case he is asked to vacate the farm.*

The long lease was found unsatisfactory in England because: (a) The tenants exhausted the soil during the last years of the lease, leaving the farm in such a state that several years were required to put it again in condition to yield profits. (b) Changes in prices during the term of the lease resulted in the rent being too low during periods of rising prices and too high during periods of falling prices. The former discouraged the landlords in using 21-year leases, and the latter "broke" the farmers and left many farms untenanted.

The long lease is not favored in the United States, for the reason that most landlords are retired farmers who expect their farms to be sold in a few years, and most tenants expect to remain only a few years on leased land before they buy a farm.

**Cash rentals.** Cash leases are universal in England, which is the classic land of tenant farming, but in the United States cash rentals are less common than share rentals. Of the 2,354,676 tenant farmers in the United States in 1910, 1,399,923 were share tenants, 128,466 were share-cash tenants, 712,294 were cash tenants, and 113,993 were unspecified.

Cash rent is usually preferred by tenants who have plenty of capital and enough experience to act independently of the landlord. This independence is highly prized by many tenants. Cash tenancy encourages a more intensive culture than share tenancy, because all of the extra annual product due to better culture goes to him who stands the cost of this culture, whereas the share tenant gets only a part of this extra product. In general, it is believed that the experienced tenant can make more money on a cash-rental basis than on shares.

As a rule, landlords who are not close at hand to look after their farms find it better to rent for cash. This guarantees the landlord a definite amount of rent, and while the total receipts of the landlord are probably lower than a well-managed share system will yield, yet the fact that the trouble is less and the risk is less makes many owners content to rent for cash.

**Farming land on shares.** This method has many advantages. The risk is less for the tenant. The amount of capital required is less where the landlord furnishes a part of the equipment. The young tenant benefits by the advice of the landlord, who has retired from his farm and who best knows its possibilities. Landlords take more interest in putting in good improvements on share-rented than on cash-rented farms.

The disadvantages of share tenancy arise when landlords and tenants fail to agree on the management of the farm, or when either party fails to live up to his agreement. The danger is that the tenant who furnishes all the labor will slight the work, to save expenses or even in order to be idle. The landlord, on the other hand, often looks upon the tenant as free labor, and expects more than is reasonable in the way of intensive cultivation of the land and care of the livestock.

The methods of letting land on shares are so varied that a brief description of the forms of share tenancy is essential to an understanding of the subject. Share tenancies vary with respect to (a) the proportion of the product received by each party; (b) the equipment and supplies furnished by each party; and (c) the degree or extent of control that is exercised by each party.

**The fourth system.** One fourth the product is the lowest share rent which can be said to exist to any great extent in the United States. This system is found on the western edge of the wheat region of the Dakotas, Nebraska, and Kansas, and also in Oregon and California. In general, it may be said that the fourth system exists in the North only on relatively unproductive lands. In the South, the practice of giving the landlord one fourth of the cotton crop is very common wherever white tenants engage in cotton production. It is here most generally found in conjunction with a "third" system for the grain crops. It is common in the South to speak of the "third and fourth" system, which usually means that the landlord receives one fourth of the cotton and one third of the grain crops.

In the fourth system the tenant usually furnishes all the equipment and seeds, but, in case commercial fertilizer is used, as is sometimes the practice in the cotton country, the landlord pays one fourth the cost of it. In the northern states, the landlord often furnishes nothing but the bare land for one fourth of the crop.

Under the fourth system the tenant is usually left free to produce the crops as he pleases, the landlord exercising little control beyond the determination of the crops to be grown and the area of each.

**The third system.** The one-third system is very common throughout the United States except in the regions of very high land values in the north-central states. Under this sys-

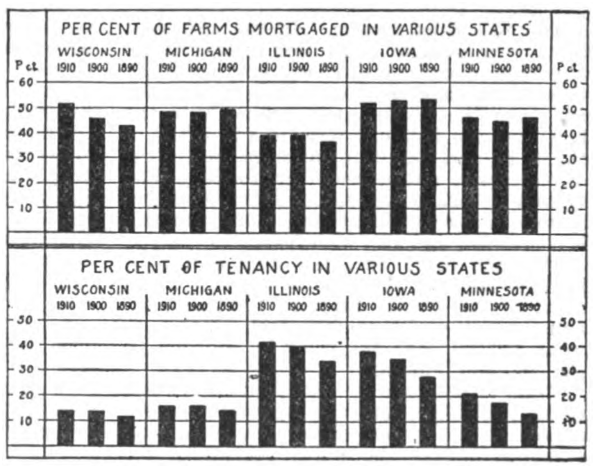



FIG. 56. Neither tenancy nor the farm mortgage is necessarily a sign of poor farming; much depends upon why and how a farm is mortgaged, and under what conditions it is rented. Where land is high-priced, as in Illinois, many a good farmer makes his start as a tenant. In newly developed territory, as in Wisconsin, a mortgage is often a wholly legitimate means of supporting a newly cleared farm until it becomes self-supporting. (Wis. Bulletin 247.)

FIG. 57. Frequent changes of location waste the tenant's time and energy and result in poorly cared-for farms

tem, the landlord receives one third the grain and, sometimes, he receives all the straw and cornstalks and stands none of the expense of production.

The landlord receiving a third of the produce usually furnishes none of the operating equipment of the farm. In many instances, the tenant pays a cash rental for the house in which he lives and for pasture for his livestock. In many other cases, fields only are rented for one third the crop. The tenant, in such cases, lives on the land which he may have bought or leased, and takes two thirds the grain and leaves the roughage on the farm where grown. Where the third system exists with respect to grain crops, the hay crop is usually shared half and half.

Where land is rented for one third the crop, the landlord usually controls in detail the kind of crops to be grown on each field. Beyond this, he leaves the tenant to do much as he pleases.

**The two-fifths system.** In the corn belt the two-fifths system has been an intermediate stage in the rise of share rents from one third to one half the crop. This system differs from the third system primarily in the fact that the landlord receives two fifths of the grain, and the tenant receives three fifths of the grain, straw, and corn fodder. The system is usually the same as the one-third system, so far as what the landlord furnishes is concerned, and also with regard to control.

**The half-share system.** The letting of land for one half the product is found in all parts of the United States. The half-and-half system varies greatly with respect to what the landlord furnishes in addition to the land and buildings.

**Grain farming on the half system.** In one form of half-share tenancy, found in the grain regions of Minnesota, Kansas, Nebraska, the Dakotas, and in the wheat regions of the Pacific Coast, the landlord furnishes the seed grain and gets one half the crop. In these regions, it is often considered that one half the crop, with the landlord furnishing the seed, is equivalent to one third the crop where the landlord does not furnish the seed.

In central Illinois and in west-central Indiana, the landlord who receives one half the grain crops furnishes nothing but the land and buildings, and exacts a cash rental for the land used for hay and pasture. The exacting of a cash rental for hay and pasture land often accompanies the share system in the north-central states, also, where the landlord receives one third or two fifths, as well as where he receives one half of the crop. In the South, corn land is sometimes let for cash, while cotton land is let on shares. In central Illinois, the landlord sometimes demands half the grain and $1 per acre in addition, and it is the regular thing to require that the tenant deliver the landlord's share of the grain at the nearest market at such time as the landlord may desire to dispose of his share of the product. It is in the heart of the corn belt of central Illinois that the landlords are able to make the heaviest demands upon their tenants.

In eastern Ohio, in Pennsylvania, Maryland, and some adjoining territory where wheat has long been considered central in the farming system, the landlord who receives one half of the grain lets the tenant have the use of the buildings, the hay and pasture land, and all the straw he cares to feed on the farm, without any additional compensation. This custom is held to rather tenaciously, and in one instance the writer found a tenant who was making about $100 a month from his dairy. This was appreciably more than the entire value of the grown crops and yet the landlord continued to accept one half of the grain and let the tenant have all he made out of the dairy.

**The land-and-stock share system.** Another form of the half-and-half system is the land-and-stock share system, in which the landlord furnishes a part of the livestock or owns a half interest in all or a part of the livestock. This system is most common in the dairy regions of New York, Ohio, Illinois, Wisconsin, Iowa, and Minnesota. The variations are numerous, but the system has many features which are quite general. The landlord furnishes the land and buildings, including the house for the tenant. The ten-

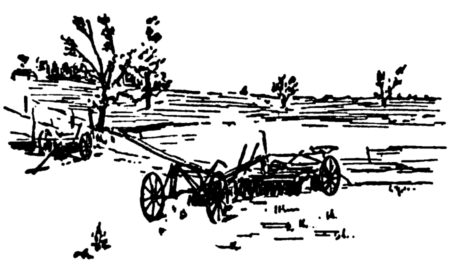


FIG. 58. Undervalued, neglected machinery is an all too common sight on tenant farms, especially where the owner supplies the equipment.

ant furnishes the horses, tools, machinery, and all the labor required to operate the farm. The landlord and tenant own jointly the cattle, hogs, and poultry kept on the farm.

The items of expense are likewise in three classes. The landlord furnishes material for making repairs, and the tenant performs the work, unless a skilled workman is required, in which case the landlord pays for the mechanic. The tenant stands all expenses in keeping his horses, tools, and machinery in working order. Expenses for twine, threshing, silage cutting, etc. are usually shared equally. The dairy equipment is often owned jointly. This refers especially to the cream separator, shipping cans, etc.

A common variation of this system is for the landlord to furnish all the cows. This is more or less common on the less valuable dairy farms of Wisconsin, and is common in New York.

**Tobacco and cotton croppers.** The form of half-share tenancy found in the tobacco and cotton regions of the United States is very simple. The landlord furnishes the land, buildings, teams, tools, and other equipment, and often advances the tenant enough goods, money, or credit to live on while making the crop. The tenant, or cropper, as he is commonly called, furnishes the labor required to produce and harvest the crop. The cotton cropper receives one half the value of his crops and free house rent and garden as pay for his efforts. In many of the cotton regions, the cropper is not an independent operator, and overseers ride about over the estate or plantation and direct the cultivation from seedtime until harvest.

**Two-thirds system.** Here and there throughout the northern states is found a farm on which the landlord furnishes everything but the labour, and receives two thirds of the produce of the farm, while the tenant, or share hand, as he is more properly called, furnishes all the man labor, and receives one third of the proceeds of the farm. While this system is found widely scattered, it is not believed to be common.

**SOME THINGS A LEASE SHOULD COVER.** There should always be a lease or agreement drawn, agreed to, and signed by both parties before the tenant takes possession of the premises. Whether the document is ever referred to again or not, it is important to go carefully over all the points regarding which differences of interest may result in disagreements. The lease should describe: (1) the land and buildings to be furnished by the landlord; (2) the uses to which the land may be put; (3) the additions and repairs to buildings which the landlord will make and the time the work is to be done; (4) the livestock and other equipment or share in the same which each party is to furnish; (5) the kind of farming which is to be carried on; (6) the character of payment (cash or share) and the amount or proportion to be paid as rent; (7) what the tenant is to do in making repairs and in helping with new buildings; (8) who is to pay the following: taxes on farm, taxes on jointly owned livestock and equipment, the threshing bill, the twine bill, the ensilage-cutting bill, the shredding bill, the corn-shelling bill, and the cost of hauling the products to market.

The aim should be to project the mind through the activities of the years for which the lease is drawn and to state who is to furnish each thing needed, what may be done and what not, who is to do each thing to be done and who is to settle each bill which must be paid.

**Form of a cash lease.** The proper form of a cash lease is as follows:

"This Indenture, made this .............. day of .............. A. D. 19.., between Earl E. Johnston party of the first part, and Geo. H. Thompson party of the second part,

"Witnesseth, That the party of the first part, in consideration of the covenants of the party of the second part, hereinafter set forth, does by these presents lease to the party of the second part the following described property, to wit:

..........................................

..........................................

in the ..................... county of .............. and state of ..............

"To have and to hold the same, to the party of the second part, from the .......... day of .................... 19.., to the ................ day of ................ 19... And the party of the second part, in consideration of the leasing the premises as above set forth, covenants and agrees with the party of the first part to pay the party of the first part, at ........................ as rent for the same, the sum of ............ dollars, payable as follows, to wit:

..........................................

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . And further to do all the work and perform all of the covenants hereinafter mentioned, as part of said rent.

"And the party of the second part covenants with the party of the first part that at the expiration of the term of this lease he will yield up the premises to the party of the first part, without further notice, in as good condition as when the same were entered upon by the party of the second part, loss by fire or inevitable accident and ordinary wear excepted.

"It is further agreed by the party of the second part, that neither he nor . . . . . . . . . . . . legal representatives will underlet said premises, or any part thereof, or assign this lease, without the written assent of the party of the first part had thereto.

"And it is further expressly agreed between the parties hereto, that if default shall be made in the payment of the rent above reserved, or any part thereof, or any of the covenants or agreements herein contained to be kept by the party of the second part, it shall be lawful for the party of the first part or . . . . . . . . . . legal representatives to enter into and upon said premises, or any part thereof, either with or without process of law, to reënter and repossess the same at the election of the party of the first part, and to distrain for any rent that may be due thereon upon any property belonging to the party of the second part. And, in order to enforce a forfeiture for non-payment of rent, it shall not be necessary to make a demand on the same day the rent shall become due, but a failure to pay the same at the place aforesaid, or a demand and a refusal to pay on the same day or at any time or any subsequent day shall be sufficient; and after such default shall be made, the party of the second part and all persons in possession under . . . . . . . . shall be guilty of a forcible detainer of said premises under the statute.

"Said party of the second part further agrees that he will, at his own expense, during the continuance of this lease, keep said premises, fences, and every part thereof, well built up and in repair; that he will cultivate the land well, plowing it at least four times, and fall plow to kill weeds; to kill and weed out all cocklebурs and other noxious weeds; mow the roads and cut all the weeds by buildings, hedges, and fences in and around the land he tends, and haul out all the manure and spread it on the poorest land; that he will trim and plash the hedge, at the proper time and in a workmanlike manner, in and around all land leased; hedge on all outer lines to be kept not higher than four and a half feet and to be trimmed at least once each year, not later than February 20, such hedge being trimmed so as to fully comply with the law; or, if he fail, said Johnston may hire it done at his expense, if not done in time, as before agreed; and that he will keep up his hogs and be responsible for all damage they may do; that he will rotate his crops, alternating with corn, small grain, and grass, sowing grass seed as said Johnston may require; that said Johnston may enter and improve, at any time he may see proper; and fix fence, fall plow, build, etc. He also agrees to sow in small grain and grass all but forty acres of corn to each hand and team, and also to look after, and be responsible for any waste in, said Johnston's property in the place. And he also agrees not to set out any fire or put any ashes about the buildings to endanger insurance, or any dirt about the buildings in spring, or anything to subject said Johnston to damages.

"It is further agreed by the said party of the second part, that as further rent for said premises, he will haul upon said premises, and upon the lands as designated by said Johnston . . . . . . . . . . . . . . full loads of manure; or in default of hauling said number of loads before the . . . . . . . . . . . . . . day of . . . . . . . . . . . . . . . . . . . 19. . . . will pay to said Johnston $. . . . . . . . for each load not so hauled. That he will also mow all the spots of weeds and grass in the fields and around the hedges and buildings, and in the roads adjoining said land, the full space of . . . . . . . . days before the weeds are ripe; and in default shall pay to said Johnston $. . . . . . . . . . for each day's failure. Said party of the second part further agrees to make all repairs upon said premises at his own expense, and at the expiration of this lease to leave them on the premises, agreeing to remove nothing without the written consent of said Johnston; and that he will keep his cattle from eating the hedge or doing any damage.

"And it is expressly understood and agreed that the said party of the second part will promptly and faithfully perform each and every one of the special clauses of this lease, and in case of his failure so to do, at the proper time, in the proper manner, and to the full extent, he hereby agrees that said Johnston may hire the work to be done by competent parties, who are hereby given permission to enter upon said premises for the purpose of doing such work; and all sums paid by said Johnston on account thereof shall be added to the principal amount agreed to be paid herein, and shall become due and payable on the . . . . . . . . . . . . . day of . . . . . . . . 19. . .

"And it is further covenanted and agreed between the parties aforesaid, that no pasture or meadow land shall be broken up without the written consent of the said Johnston. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

"The covenants herein shall extend to all and be binding upon the heirs, executors, and administrators of the parties to this Lease.

"Witness the hands and seals of the parties aforesaid, the day and year first above written.

....................Seal.
....................Seal."

..............................

In Mississippi, the forms used in contracting with croppers on a cotton plantation are as follows:

"I hereby agree to cultivate ( ) acres of land, on that part of the .... plantation known as ...... during the year ( ) under the direction and supervision of the owner, ...... or his agent. I agree to gather and house the same in good condition, for which service I am to receive one half the crop.

Signed ................ (cropper).
Witness..........
Date ..........."

---

Another used on a large Washington County plantation is a little more detailed; it reads:

"This Contract, Made this (*Date*) and terminating one year hence, between D. and D., and ................................ witnesseth: That D. and D. have this day set apart to him for the year 19.., certain ...... acres of land on D. and D. Plantation, Washington County, Mississippi, to be worked by him on 'Shares'; he also agrees to plant and cultivate all land allotted to him, including the edges of roads, turnrows, and ditch banks, and to keep the latter clean, and to plant no gardens or truck patches in his field; and that he will not neglect, leave, or turn back his crop until entirely gathered, and that if he should leave same, he will thereby forfeit all right he may have therein.

"Witness our signatures, this the ........ day of ............. 19..

"Witness:— ....................
....................."

---

In a combined lease and partnership, the following covenants are entered into:

"This indenture made this ............ day of March, 19.., between ............ of the city of .................., county of .................., state of ..........., party of the first part and ................ of said city, county, and state, party of the second part.

"Witnesseth that ................, party of the first part, agrees to let his farm, etc. (Here follows the description of the farm which consists of ........ acres of arable land and .......... acres of pasture land), to .................... party of the second part.

"It is agreed between these contracting parties, that they are to jointly buy and own all personal property (except horses, tools, and machinery) that is needed and used in conducting operations on this farm, including cattle, sheep, hogs, poultry, seeds, and feeds of all kinds required in operating the farm, and share alike equally all profits and losses resulting from same.

"It is agreed that the said party of the second part is to furnish all the horses, harness, tools, and machinery needed in operating the farm and to perform or pay for the performance of all labor used in conducting operations on said farm except it be for the repairing or painting of buildings which the party of the first part must be holden for unless they be minor repairs.

"Also that said party of the second part is to build and keep in good repair all fences on said farm, all the material used for same to be furnished at the nearest market by party of first part at his own expense.

"Also all grass seeds are to be furnished by party of the first part.

"Also that said party of the first part is to pay all taxes on realty, and the taxes on personal property are to be paid jointly. Also that the work horses are to be fed out of undivided hay and grain, except in case the party of the second part should desire to do teaming for his own profit in which case he shall feed team from his own hay and grain, also the number of work horses shall be limited to ......, and should colts be raised they shall be the common property of owner and tenant.

"Also the bill for threshing grain or seeds, for binder twine and ensilage cutting shall be paid jointly.

"It is agreed also that all ditches forming on the land are to be properly filled at the proper time by the party of the second part.

"Also that all noxious weeds are to be cut at the proper time and the weeds of any description on the highways adjoining the above described land are to be cut to the middle of the road by party of the second part.

"Also the party of the second part agrees to haul out and distribute upon said farm, at places most needed, all manure made thereon, and at such times and at such places as shall be designated by the landlord.

"Also all dead trees in the grove to be used by party of the second part for firewood, if he wants the same, also all refuse from buildings and fences not fit for use again.

"Also all brush and weeds of any description, growing along the rows on said farm to be kept cut by party of the second part.

"It is further agreed that no stock shall be allowed in the pastures or meadows while the frost is leaving the ground or until the ground is fairly settled.

"Also that no grain or feed is to be sold off the above farm without the consent of both parties to this contract.

"It is further agreed by and between said parties that all corn fodder, straw, and other rough feed raised upon said farm and not fed

out at the expiration of this compact is to be the property of the landlord.

"Also that when stock or grain, wool, poultry, or dairy products are sold they shall be delivered on the market by the tenant.

"Said party of the first part also reserves the privilege of plowing the stubble or stalk ground on said premises when said party of the second part may have secured the crops or grain grown thereon, and may enter on said premises at any time for purposes of improvement, or for any reasonable purpose which said party of the first part may deem proper.

"And it is further understood and agreed that if party of the second part shall abandon said premises, or shall fail from any cause to comply with all his agreements herein, the said party of the first part may at any time, when such abandonment or failure occurs, take actual possession of said premises and buildings thereon, which said party of the second part agrees to surrender, and said first party may employ other persons to tend said crop and harvest or gather the same, and may remove and sell the same at public or private sale and apply the proceeds thereof to the expense and cost of carrying out the provisions of this lease and the payment of said rent hereby reserved, and all advances, and if the proceeds of the crops as aforesaid shall not be sufficient to repay said first parties all the money so expended, the said party of the second part agrees to refund to said parties of the first part such deficiency on demand out of any other property belonging to the said second party.

"And it is further expressly agreed between the parties hereto, that if any default shall be made of any of the covenants and agreements herein contained to be kept by party of the second part, this lease shall at the election of the parties of the first part be null and void.

"Also that the said lease of the above described land is to run from March .......... 19.., for the term of ............ years, and at the termination of said lease, should a dissolution be agreed upon, all personal property is to be equally divided between said parties. In cases of hay and grain the division is to be made by measurements, each party receiving one half of each grade of the products to be divided. In the case of livestock to be divided, the party of the second part shall divide each class of cattle, sheep, hogs and poultry into two lots, and the party of the first part shall take his choice of lots, the party of the second part accepting the remaining lot of each class of stock as his share of the livestock.

"Witness our signatures this the ........ day of ................19....

....................

...................."

## Hired Managers and Workmen

**Farm owner and hired manager.** The relation between the farm owner and the hired manager should be one of mutual confidence and understanding. The general policy of the farm should be laid down clearly by the owner, and it should be the duty of the manager to carry out faithfully the details of such policy so laid down, using his own discretion where unforeseen events arise.

The details of management, the programme of the day, the hiring and discharging of subordinates, the calling of the veterinarian, etc., should be left to the manager, who should always make his decisions on the basis of the best interests of the farm so far as they are consistent with the honest and humane treatment of men and beasts. The manager on a definite wage basis must take great care to keep his own personal interests in the background, wherever they conflict with the successful operation of the farm. The operation of a farm by a hired manager is the least successful system of farming in use in the United States.

The most successful farm organization is found where the farmer and his family do all the work. The management is usually the result of family conferences held about the dining table, in which everyone has his say and the father makes the final decisions. In some families, the danger is that the growing children will work too hard; but in many other families the danger is that the children will not do enough work and will grow up without developing industrious habits.

In farming, especially in livestock farming, there are so many details which require the careful attention of interested workers that the ordinary irrespon-

sible wage worker is almost useless. The family organization gives control over the family labor when necessary, and the community of ownership of the proceeds gives interest to each worker in securing good results.

FIG. 59. While there are frequent exceptions, it may generally be noted that a region in which short-term tenancy is common, is characterized by poor roads, and the various undesirable conditions (such as poor schools and churches) that accompany them.

**The farmer and the hired man.** Whenever the family does not meet the demands for labor, the effort should be to employ men who will become coherent parts of what may be called an "artificial farm family." To some farmers, this may seem objectionable. If this be so, it is recommended that the size of the farm be reduced to correspond to the family labor force. The hired man is usually a young man, unmarried. The farmstead is an isolated centre of life and industry. All who participate in the industry of the farm should be privileged to participate in the life of the farm home. The artificial family established, the hired member should have his say in the management of the farm, as do the original members of the family. This engenders interest in his work, and results in the more faithful carrying out of details, as well as the putting forth of great effort in times of emergencies, and the general goodwill and comity of the group.

**Transient labor.** On specialized wheat farms, for example, the demand for labor in the harvest and threshing season is much greater than at any other season of the year. The specialized wheat farm which is large enough to use the family labor during the remainder of the year cannot be operated without extra labor in caring for the crop. This makes a demand for transient labor. Transient laborers are as a class undesirable citizens. The type of farming which encourages this class should be avoided. Where wheat is grown in rotation with other crops which are fed to livestock, the demand for labor is more evenly distributed through the year, so that more nearly all the labor can find continuous employment on the farm. This is the important means of holding men of character and ability.

**Exchange labor.** The most satisfactory method of securing the large crew of men required for threshing grain or cutting ensilage is to exchange work with the neighbors. It has been said that exchange labor is not subject to control and that many men are inclined to shirk. There are neighborhoods where this is true, but there are other neighborhoods where the workmen compete with each other in winning praise for both the quality and the quantity of work done. At their worst, exchange laborers are as good as transient laborers, and they have an especial advantage for the farmer in that they do not have to be lodged, do not arrive until after breakfast, and they go home if the work has necessarily to be stopped for a day or so because of rain or a broken machine. The transient must be lodged and fed whether the work moves on or not. Furthermore, the transient may leave at any moment without provision for anyone to take his place.

**Sharing profits.** Sharing profits without sharing risks is not common in this country. The one profit-sharing system which works is share renting. Here both parties participate and both share in the good or bad results of the year's operations. Profit sharing with managers and workmen has been tried in various forms, but with no marked success. The difficulty of knowing what the profits are makes it hard to adjust the payment. A more satisfactory plan is for the owner to pay standard wages, and then pay each man a bonus according to merit. It is believed that such bonuses should never be pointed to as an inducement for men to remain or to work harder. The bonus should be an unclaimed gift freely given and joyously received. A bonus of a few dollars from time to time closely associated with overtime or the exercise of good judgment in a crisis is always helpful.

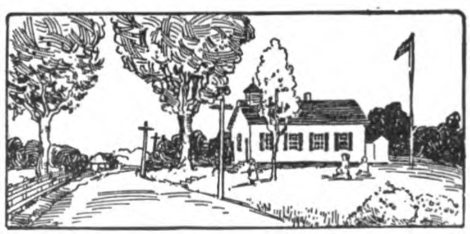


FIG. 60. A community of owned farms, on the other hand, is usually marked by better-kept-up homesteads, better roads connecting them, better schools and meeting places and, in general, a spirit of greater progress and social advancement.

**FIG. 61.** A coöperatively owned and operated limestone crusher and shell grinder. With such a machine, a group of farmers can benefit their own farms and make a comfortable profit by helping others to do the same

# CHAPTER 6

# Coöperation in Farming

*By* JOHN LEE COULTER, *Dean of the College of Agriculture and Director of the Agricultural Experiment Station of West Virginia, who was born on the farm, lived there until past 20 years of age, and has since devoted 99 per cent of his efforts in the direction of actual farm operations, assisting farmers generally to improve their conditions. He has taught in the Iowa State College and the Universities of Wisconsin and Minnesota; he was special agent in charge of the Division of Agriculture of the U. S. Census in 1910–12; and he was a member, and the secretary, of the commission sent to Europe to investigate rural credit and coöperation. Thus he formerly gave much of his time to special problems of coöperation; during recent years he has broadened his field to include consideration of all farm problems. As Dean of the State College he has supervision over the operation and development of 6 separate farms totaling some 2,000 acres and representing poultry, livestock, fruit and truck, dairy, field crop and general farm activities each carried on according to the most up-to-date, successful methods. He has organized coöperation organizations and carried them to permanent success; he has visited practically every country in the world and all parts of this country in studying coöperative and agricultural conditions generally. A more thoroughly informed, more deeply interested, more widely experienced authority could not be found to discuss this tremendously important subject.*—EDITOR.

COÖPERATION as a word in common use outside of the field of agriculture is, when used literally, a very general term. It means merely "working together." The working together may be in the form of a definite and permanent association or organization or it may be informal and temporary. During recent years, the word has been given a very special meaning, particularly in the field of agriculture. Here it means more and more the formal organized working together on the part of country people with a definite purpose in mind. But in country life, as in life generally, there probably is as much informal as formal coöperation.

In any careful attempt to identify all forms of coöperation there should be definitely recognized: (1) Local, temporary informal coöperation without any special organization; (2) local, formal coöperation in the form of clubs, rings, circles, societies, associations, etc. for some local benefit or improvement; (3) formal business coöperative societies, in contrast with formal business corporations; (4) farmers' organizations for educational, social, and general advancement of the rural life in general; and (5) compulsory legal coöperation.

**Compulsory legal coöperation.** It will not be necessary to take much time to describe the fifth type of coöperation, yet it is as important as, or more important than, any of the other types. A good illustration of compulsory legal coöperation is found in our system of free

schools which now prevails in practically all parts of the country, rural and urban. The majority of the people, coöperating through representatives in legislative bodies, pass rules and regulations dividing the nation into states and the states into counties or parishes; setting aside cities, towns, and villages; and further dividing incorporated places into wards or other units, and dividing rural territory into townships, magisterial districts, precincts, or some other practical unit in order to perfect a system of compulsory legal coöperation. As a result of this division, school districts are maintained and all of the citizens of the community coöperate both in the support of the schools created and in the benefits derived from them. Generally, there is no direct relation between the cost to the individual in the form of taxes and the benefits derived. The largest property owner and the largest taxpayer may have the fewest children and may directly gain little from this compulsory coöperation with neighbors, while the home with the largest number of children, securing the greatest direct benefit, may contribute the least for the maintenance and support of the schools. It is the belief, however, of the great majority of democratic society that the indirect benefits which come to all equalize matters sufficiently, so that it seems wise throughout the length and breadth of the United States to continue to maintain this system of compulsory coöperation.

It may be worth while to give a second illustration of compulsory coöperation; this is found in the establishment and maintenance of the road systems of country districts and the street systems of cities, towns, and villages. Every reader will call to mind the coöperative arrangement by which roads and streets are planned, established, and maintained.

**Our church and Sunday school systems.** Closely related to the above illustrations of compulsory legal coöperation, and yet without any of the legal features and without any compulsion, is the complete system of churches and Sunday schools maintained throughout the length and breadth of our land. Probably there is not a city, town, or village, and not a rural community with a dozen families where the most thorough system of coöperation for the maintenance of a church or a Sunday school is not found. Coöperation for the establishment, maintenance, and operation of churches and Sunday schools is brought in here only because it is universal and not because it is compulsory or established by legal action. Yet, it is the best illustration of coöperation carried out universally in this great democracy on a purely voluntary basis, and is probably the best example of coöperation of the fourth class referred to above. Details need not be given. Students and advocates of coöperation in farming would do well to make a thorough study of the operation of our school, road, and church systems, if they would understand and most successfully develop other phases of coöperation.

**Organizations for social and general betterment.** As we turn now to other organizations in agriculture aiming at educational, social, and general rural betterment, we find a long list of movements which give us a basis of study indicating what the future should be. Going back to colonial days, even then there were agricultural associations. Some of these carried on supplementary works outside of the educational and social. Some were interested in the agricultural press and started our first farm papers. Some interested themselves in fairs and exhibits; some, in the introduction of better seeds, better plants, better animals, better tools, implements, and machines, and better agricultural practices. Even before 1860 some took up the problem of distributing the products of the farms and devoted most of their attention to the problem of marketing. Prior to the middle of the last century (1850), however, there was, outside of the organizations for schools, roads, and churches, no great national association of country people to deal with the special problems of country people. By 1867 this movement had begun, and since that time the rural United States has shown its ability to organize for general rural development. Mention may be made here only of such organizations as the National Grange, the New England and National leagues, the Agricultural Wheel, the Farmers' Mutual Benefit Association, the Farmers' and the Citizens' alliances, the Farmers' Educational and Coöperative Union, the Society of Equity, the Gleaners, and some others of the past as well as of the present day, which, however, are far more completely organized for purely business purposes than for educational, social, and general rural improvement. It is not to be understood that the organizations named above were established purely for educational

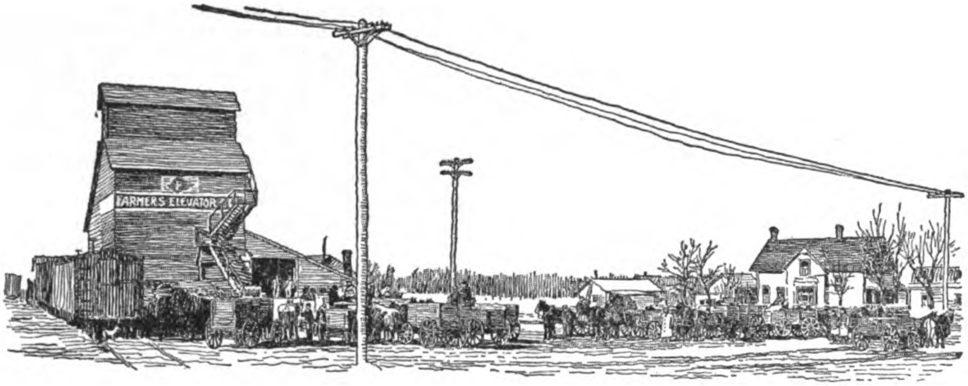



FIG. 62. A farmer's coöperative elevator company in Minnesota that handles seeds, coal, salt, posts, fencing, flour, and feeds as well as grain. The aid and loyalty of its stockholders is at the bottom of its success

and social purposes; some have had, and still have, the characteristics of a lodge, while others added many types of business organization and some engaged in political activities. Some have lived throughout the entire period, at times growing stronger and at times, through some error of policy, becoming weaker. The genius of organization and improvement through coöperation, both formal and informal, is fully illustrated in this great movement for the general upbuilding and improvement of country life. It may be said, taking the whole situation by and large, that the inclination on the part of rural people to coöperate has increased from decade to decade, and at the present time membership in some rural organization is more nearly the rule than the exception in many parts of the country, especially where most farmers are landowners and where the country is well settled.

During the earlier period of our country's growth the general organization, such as an agricultural society with many functions, predominated, whereas the special agricultural society with a specific purpose was the exception. This is only natural, yet it marks one of the fundamental reasons why great progress, improvement, and benefit were not secured in the earlier period and why, during the later years and in the future, the benefits increased and will increase, the possibilities for improvement being unlimited. Probably the greatest reason for the success of the coöperation which resulted in the schools, churches, and roads, is the fact that those interested got together for a definite purpose and did not allow any other activity to interfere. At the same time, it may be said that much of our failure in later years is due to the fact that the groups have attempted to cover too many things and some or all have been neglected, resulting in failure.

**Coöperative organizations for special purposes.** One of the striking characteristics of the last half-century was the development, perfection, and permanent establishment of coöperative organizations for special purposes, which have proved their worth and, in the future, will prove more and more their usefulness. This group of activities includes the various livestock breeders' associations, including the many poultry and bee keepers' societies. It also includes special organizations, such as the fruit growers', wool raisers', grain improvement, and cow testing societies. This great group of coöperative organizations have in mind almost entirely, or at least primarily, the improvement of agriculture from the standpoints of better, more uniform, and higher production. In some cases it is a greater yield through better seeds, better animals, or better plants; in others it is a greater yield through better care, treatment, or management; in still others it is a better

product, such as finer animals, better fruits, better wool, or better cotton. All of these are representative of specialized coöperation in farming. They have evolved from the more general agricultural organizations of the earlier period, and seem to point clearly in the right direction. There can be no doubt that, with gradual perfection and organization, coöperation will bring to the farmers of this country an improvement in production in agriculture which could not have been secured in any other way.

It may be said that these types of coöperation are forms which are only temporary; that they supplement the educational institutions of the past, and will disappear with the perfection of the agricultural educational institutions of the future. It is even the ambition of some leaders in the educational world, with the introduction of formal agriculture in the elementary schools and now in the high schools as a result of the Federal Smith-Hughes Act, and with the development of each college of agriculture with its great arm extending out all over the state in the form of the extension service, that all of these special agricultural associations shall be consolidated into general and special coöperative bureaus, each coextensive with some political unit such as the county or parish. There is, indeed, much to be said in favor of the correlation of all of these coöperative activities into coöperative county and state federations. The success of this federation and standardization will, however, long depend upon freedom of membership, the independence of choice on the part of farmers and their families, and the absence of anything which has the appearance of compulsory membership. It is also extremely important that each activity be kept free and independent with a chance to win a way for itself.

While the school systems, both elementary and high, will surely be maintained with a large element of universal requirements, such as compulsory attendance during certain seasons of the year, the genius of the rural population of our country must be given opportunity of expression in the supplementary work of improving itself through voluntary coöperation in the form of associations for the improvement of the rural territory. The most that the educational institutions can do through boys', girls', men's, and women's clubs, through fairs, institutes, extension schools, reading circles, demonstrations, rallies, and the like, is to supplement the formal school systems and place at the disposal of the rural population the very latest and the very best. It will be, and should be, many years, if ever, before these voluntary organizations of rural folk will be standardized and forced into a uniform mold similar to the schools. Rather they must follow the voluntary movement of the churches, where freedom of development should and must prevail.

**Informal community coöperation.** Passing for a moment the formal organization of those engaged in agriculture for purposes of rural insurance, the selling of their products, and the buying of supplies, and examining the informal local community movements, we enter a great field illustrating the genius of the rural people of America for coöperation for mutual advantage and benefit. This informal community coöperation takes many forms. A good illustration of this is the old-time barn raising, the husking bee, the quilting party, the silo filling, and the canning party. Unlimited examples could be given of this informal local temporary community coöperative movement. In this same group might be included other spontaneous organization. In nearly every community of our country boys form baseball teams or organize for other sports. The same may be said of girls who are now organizing clubs, such as the Camp Fire Girls. We see this also in the spontaneous getting together of groups of country people for basket socials, dancing parties, sleighing parties, and the like.

This all brings us to the final group, which is most commonly brought forward when the subject of coöperation in farming is considered. This group includes coöperation among groups of neighbours living upon farms for the establishment of a rural telephone system, for the establishment of a blacksmith shop, for the ownership of some important piece of machinery, for the organization and operation of a mutual insurance company, for the establishment and operation of storage buildings, such as elevators and warehouses, for the organization and operation of manufacturing establishments, such as cheese

FIG. 63. A group of competing elevators in a section where coöperation is yet to be established. Contrast with Fig. 62 and think of the waste in duplicated buildings and labor, and the lessened profits on account of the splitting up of the returns.

factories, creameries, and condenseries, for the making of cider and vinegar or the ownership of a press for making sirup or the operation of a plant for canning, preserving, or drying fruits and vegetables, and, finally, coöperation for the selling of the products of the farms, including their standardized grading, sorting, weighing and packing, and for the buying of supplies needed in the operation of farms. This last great group is primarily the great field of business coöperation in contrast to the system which might pre-

**vail, namely, that of depending entirely upon outside parties to own and operate institutions which farmers might patronize. The question of the exact form of operation, which is quite a different one from that of the purpose of the organization, is discussed below, under the section "How farmers can coöperate."**

## What Coöperation Does

The coöperation which resulted in the establishment of a complete school system has meant uniform popular education, and this in turn has meant the success of democracy. Without this universal coöperation on the part of all of the people, the American nation might very well have been not unlike the Russian nation with 15 per cent of its population educated and the other 85 per cent illiterate. In turn, without this coöperation and universal education, it would have been impossible to maintain democracy. This nation would certainly have changed into some form of government controlled either by a powerful, favored few (an *oligarchy*) or by financial interests (a *plutocracy*) or by an educated upper class or aristocracy. It cannot be said that this is not a true and fair presentation of the effect of universal coöperation. The only unfair feature of this form of coöperation is the fact that the few who oppose and object to it are compelled to continue their coöperation by the great majority. The few parents who do not wish to send their children to school are compelled to do so by the great majority, and the few children who do not wish to go to school are similarly compelled to go. The result is a form of universal coöperation which is the foundation stone of the democracy.

**Coöperation and our road system.** The value of coöperation in the establishment and maintenance of a good road system is self-evident. Here, again, the great majority of the people have determined upon the establishment of roads through coöperative organization; and, in order to make it effective, the whole thing has been systematized into the form of laws. Good roads make possible community association; and it may be said that universal coöperation for the establishment of roads was the preliminary step toward better transportation, better communication, and better education (through the establishment of schools).

The danger of emphasizing universal coöperation in the building and maintenance of roads and schools is that some may feel that this is not true coöperation because the majority compels the minority to concur in its actions; it would perhaps be better to cite our system of churches and Sunday schools as the ideal illustration of universal coöperation. Nearly every family in the United States of its own free will and accord is associated with some church and, through that church, with some Sunday school. This is coöperation of the truest type. It is purely voluntary, since no family need belong to any church. The greatest freedom of action exists. The purpose of the coöperation is in some ways very definite and in other ways very indefinite. The success of our whole religious system is an evidence of the universal willingness of the people to join together for some definite aim. In this connection it is very significant that all do not belong to one church—that there are a number of different churches represented in most communities. This would seem to indicate that no perfect, ultimate, finally successful type has yet been established. The individuality and independence of human minds has here an admirable opportunity to work out further plans or programs which seem best to them.

It is best, however, not to lay too much stress upon coöperation in the establishment of religious institutions, because, while this is practically universal and purely voluntary, it is possible for a large number of different groups to coöperate successfully and survive in the same community. In the matter of

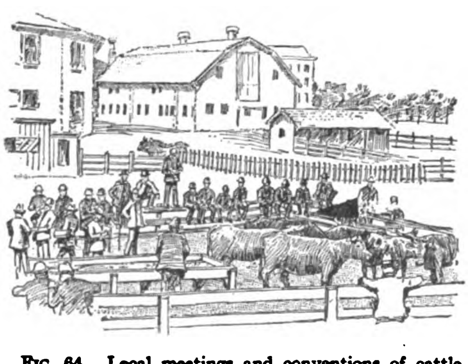
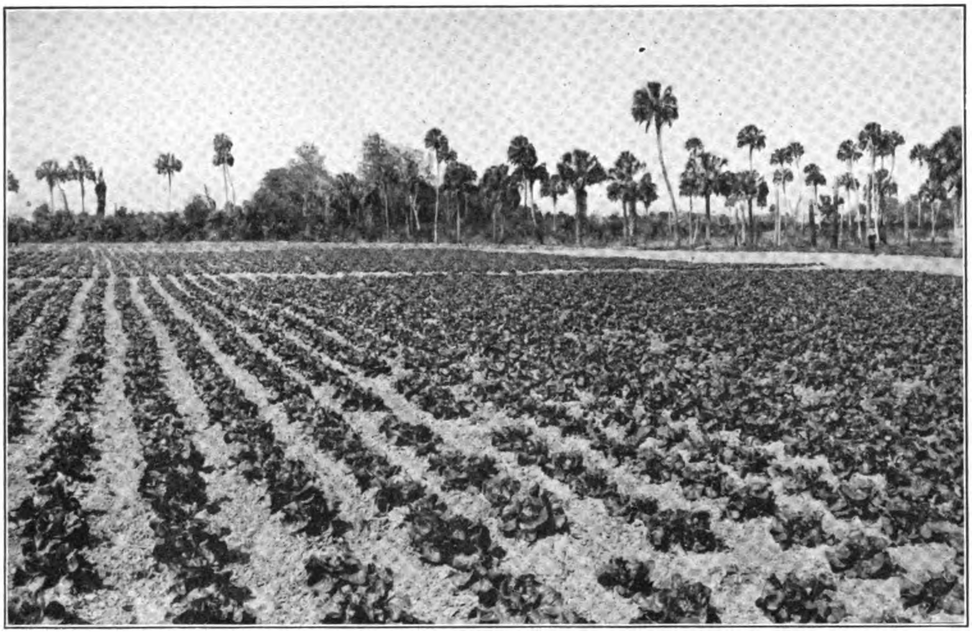


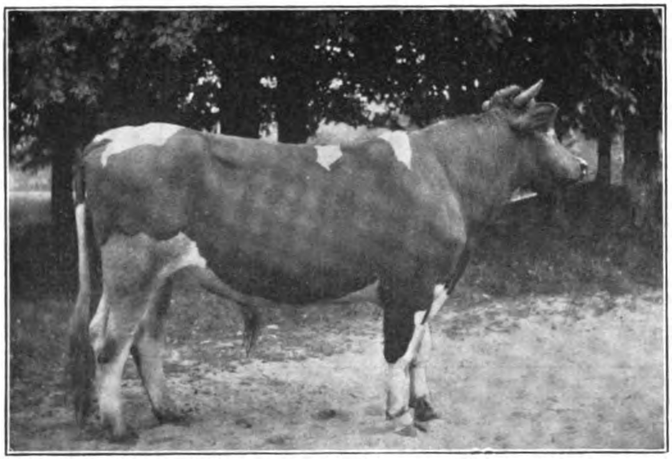
FIG. 64. Local meetings and conventions of cattlemen are often the starting points of, and sometimes the outgrowths from, coöperative movements. In either case the result is a highly desirable one.



Lettuce on a southern truck farm which typifies the producing end of the farm business

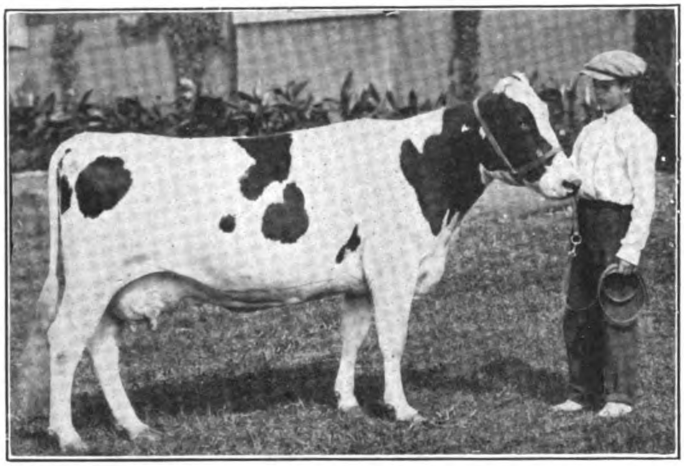
South Water Street, Chicago—one of the largest and busiest of the world's distributing centres for farm produce—is an example of the consuming end

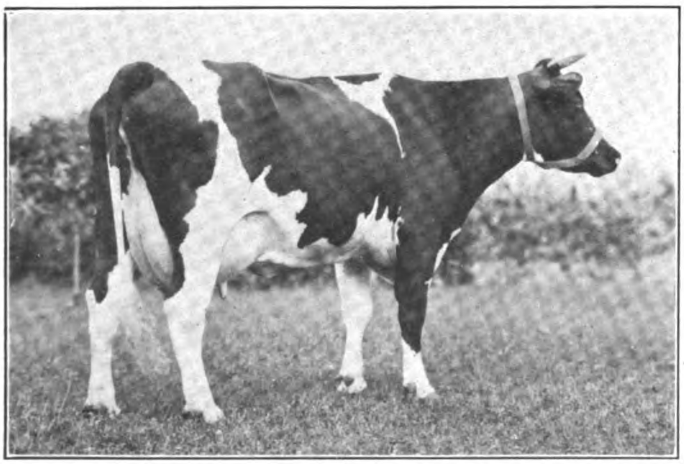
Too Often the Farmer's Knowledge of His Part in the Business of Food Production is Developed at the Expense of a Knowledge of the Other End. He Must be a Salesman, Too



This animal is dirty, and the poorly chosen background fails to bring out its desirable conformation.

This is a good picture of a good animal well-groomed and well-posed against a good background. It tells the truth, and in an attractive manner.





The flanks of this cow, being much nearer the camera than the head, are distorted and out of proportion, weakening the entire effect.

CAREFUL PHOTOGRAPHY IS AN INVALUABLE FACTOR IN SUCCESSFUL, MODERN LIVESTOCK ADVERTISING. (Courtesy Holstein-Friesian Association of America)

many other types of coöperative endeavor an understanding of 2 great facts is necessary: (1) it is out of the question to provide plans whereby the majority shall compel the minority to participate; and (2) it is impossible to maintain two or more competing institutions of the same type in the same community. The success, then, of the widest and best coöperation in many fields will depend upon the ability of the great majority—without compulsion and without duplication—to establish successful coöperative enterprise. While it may be said that progress in coöperation during the last 100 years in this country in this third great field has not been great, nevertheless it has been far beyond anything which might have been predicted or could reasonably have been expected.

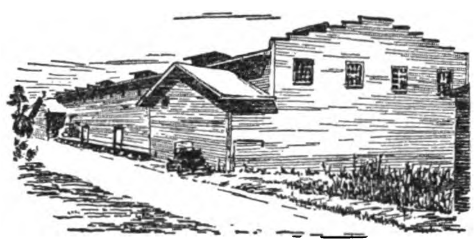


FIG. 65. A coöperative fruit packing and storage house in the Northwest. What a single farmer cannot afford to do can often be done by a score working in unison, with increased profits as well as lessened costs for each. (U. S. Bureau of Markets.)

The best measure of what coöperation does for its adherents and, to a lesser degree, for all neighboring families, is the general betterment of rural conditions as a whole. Travel the country over and, almost without any knowledge of the presence or absence of coöperative societies, one may detect when he enters a community where coöperative societies prevail. Coöperation for one object almost always means coöperation for another. For instance, coöperation in the establishment of a creamery will be followed by organization for the marketing of its product, and this will successively be followed by organizations for the marketing of other products, the purchase of supplies, and the establishment of telephones. Probably there will follow mutual insurance coöperation, and almost certainly a coöperative rural credit association. The sum total of these will mean the uplift or building up of the entire community. As, however, the upbuilding of a community is possible only through the upbuilding of the individual farms and homes, it may be said that the first problem for each community is to determine which is the most pressing form of coöperative enterprise, realizing that, as shown above, this will undoubtedly be followed by other forms all tending to the betterment of the community.

**Coöperation can be successful only when it does concrete things.** The first coöperative enterprise must have for its object the most practical, concrete thing and work for a definite useful result. A community with 100 farmers, having on the average 5 milk cows, located too far from a city to sell fresh milk, will form a coöperative butter-manufacturing establishment (creamery). The concrete thing which coöperation will do here will be: first, relieve 100 farm homes from the difficult and laborious task of making butter. The creamery will do this for 100 families. One man employed by these 100 families will do the job. This is similar to the employment of a teacher by 100 families to teach their children, thus relieving the mother and father of this responsibility. It is similar to the coöperative arrangement whereby 100 families unite in the employment of a preacher and the construction of a church. The second concrete thing will be the relief of 100 kitchens of the churn and 100 homes of the butter-making equipment, thus simplifying the tasks of the housewives. In order to do this, one kitchen, called a "creamery," will be constructed. The third concrete thing will be the fact that 100 various types of butter, differing only slightly, to be sure, but none the less differing, will be replaced by one standard type, probably as good as the best and slightly better than the butter made by the other 99. In this way the standard is raised materially. Direct results of this improvement are evidenced in the fact that during a year this one creamery may produce and have for sale 100,000 to 150,000 pounds of uniform high-grade butter which it can market in large quantities and in this way make very great economies. In this connection the creamery can secure a better market than could any one of the 100 families. The creamery will also get a better price for its butter than it was pos-

sible for the individual family to secure. With this better market and better price will come prestige.

Connected with all of this is the fact that one creamery can advertise not only its own product, but the community as a whole, so that, if the community has other products to sell, these other products will in turn bring higher prices. It is unnecessary here to attempt to give all of the economies and concrete benefits of a successful coöperative creamery, such as the saving to the 100 families in the purchase of butter-making equipment, of salt, etc. It is more than likely that the creamery will get a larger actual yield of butter because of better equipment and better methods. While the coöperative creamery has been employed here for purposes of illustration, one might with equal propriety have used the coöperative cheese factory or a coöperative establishment for making condensed milk, or coöperation for purposes of canning, preserving, or drying farm products, or it might have been better to have used as an illustration, a coöperative organization for the storage of farm products such as the coöperative elevator or warehouse. The coöperative creamery was used, however, because it is gaining such a definite and successful position in rural life in certain sections of the United States. If the coöperative cheese factory had been used as an illustration, it would have been better to refer to 50 families, each with 5 cows, since a cheese factory may be successfully operated with a considerably smaller number of cows than can an establishment for the making of butter.

**Coöperation in farm production.** In order to bring out some of the more important advantages of the different forms of successful coöperation, it is necessary to classify them into their different groups, and in that way to show their wide scope and great possibilities. Probably the type first in importance, from the standpoint of successful agriculture, is coöperation in farm production. This would include coöperation in the ownership of important tools, implements, and machines. It would also include coöperation in the ownership of very valuable breeding animals. In a community where the writer lived and farmed for many years, it was found advantageous to own one very large threshing outfit, including engine, water tanks, fuel wagons, separator, straw stacker, etc. It would have been a very great hardship, in fact it would have been almost impossible, for any one farmer to own and operate this outfit. In the first place it would cost nearly, if not quite, $5,000. It could be used only from 4 to 8 weeks each year. As no farmer could own this outfit, some outside business man would doubtless have purchased and operated it; but this would have meant very much higher charges to the farmers, since the owner who took over the risk would have expected to make reasonably good profits. The result was that a group of farmers got together and arranged to form a small company to purchase, care for, and operate the threshing outfit. They raised the necessary cash among themselves, and then each year charged regular rates for threshing. As rapidly as this money was collected, the labor was paid and repairs were taken care of. Each member paid the company for the threshing of his own grain. They threshed for a number of neighbors who were not members of the company. At the close of the year any surplus was divided among the members who owned the outfit in proportion to the amount which they had contributed originally to the purchase price. This plan worked very satisfactorily for several years and was changed only because the amount of grain produced in the district gradually declined and an increased acreage was devoted to pasture for livestock, the growing of hay and forage crops, the production of corn, etc. At this time much smaller machines were introduced.

FIG. 66. The coöperative creamery of Dassel, Minn., typifies the progress of that state in both dairying and coöperation. (U. S. Bureau of Markets.)

All over the United States will be found good examples of companies formed to own a very valuable stallion or bull, and in some European countries, especially parts of Belgium, Denmark, Holland, and several other countries literally thousands of communities have organized for this purpose. The same general plan described above in the case of the threshing outfit prevails. The only material difference between the two types of coöperation is that in the case of the threshing outfit or any other important tool, implement, or machine, it is usually unnecessary to employ a general manager or caretaker. Some member of the club may successfully and properly take charge of the enterprise, employ the engineer, fireman, and other laborers, and look after all of the business. The reason for this is that the outfit is in operation only at one special period of the year, or is transferred from one farm to another. In the case of a livestock breeders' association for the ownership of valuable breeding animals, it is very important that a regularly employed manager or caretaker be engaged, unless some one of the members has a very thoroughly organized, up-to-date farm and can do this satisfactorily to all concerned. Where only one animal is owned, this can frequently be done, but if the method pursued usually in Europe should be adopted, a regular caretaker should be employed. In traveling over Europe the writer found in nearly every case that a company of farmers would own any number from 5 to 10, 20, or even 30, special breeding animals of different ages. Sometimes these would be placed out on various farms and changed from farm to farm but they were under the direction and care and attention of a thoroughly trained livestock man.

In this same connection there should be considered another illustration of community coöperation in connection with the operation of the neighboring farms. In a community in Wisconsin a club of farmers found it very difficult to get blacksmith work satisfactorily attended to. There was the shoeing of horses, the repairing of implements and machinery, wagons, etc., the making of many small articles needed by the farmers, such as singletrees, etc. This club of farmers finally took hold of the proposition and found a young man who was well trained in blacksmithing and repair work. Having no capital, he was willing to be employed at a regular salary of $60 per month, provided a small cottage would be constructed for him to live in. The farmers formed a small company and raised slightly more than $2,000. With this they constructed the cottage and a small blacksmith's shop. During the first month, as a saving to the community, the young man was furnished with a team of horses and a wagon, and with these he went from farm to farm spending as much as a day with each farmer, and going over all of his old material lying about the farm. In this way several tons of old bolts, iron, and parts of machines, old broken tools, etc. were collected and assembled in the shop. This gave a good chance for the blacksmith to start his work. Of course he was compelled from time to time to buy materials. He kept very careful accounts on all articles purchased, and these were authorized each month at a meeting of the members. Each farmer was charged regular rates for his work done. From the receipts the blacksmith was paid his monthly wages and necessary material was purchased. For the first two or three years all of the surplus at the close of the year was invested in additional tools and equipment. At the end of this period it was found that the members could be charged a lower rate for all of their work, and on this account there has not been any material surplus since that time. The advantages to the farmers in this case are obvious. Not only do they have constantly one man on whom they may call for all repair work, but the work is done better and cheaper. Further than this, they own their own shop and find it a very profitable enterprise.

**A coöperative laundry.** It may, perhaps, be useful to give an example of community coöperation, having to do with the home itself. In a Minnesota community, it was found that one of the most unpleasant and difficult tasks in the management of the household was the problem of washing soiled garments, partly on account of the large number of laborers employed by the farmers and because of the fact that in most of the families there were many children. Along with this it may be noted that it was very difficult, in fact almost out of the question, to secure servants for the home, and that in a great many cases the farmers could not afford to employ servants. In this community the farmers themselves were already well organized and among other activities they had a coöperative creamery in a neighbouring town where each day the milk or cream was delivered from the farms. The creamery was built from brick and concrete and was a very modern plant. In connection with the creamery there was necessarily flowing water and this meant hot water and steam practically every day. The farmers' wives in this community took the matter up with their husbands and the result was that a small room was constructed in connection with the creamery to be used as a laundry, and the water and steam, together with the engine, from the creamery, were connected with it. It will readily be seen that a great burden was lifted from the backs of the women of this community. There was no cost of delivering or returning the clothes to or from the laundry, since that was done at the same time that the milk or cream was delivered. Since the

FIG. 67. A metal-sheathed farmer's elevator with connecting hollow-tile corn crib.

ironing was done at home after the clothes were returned, the cost was so small that all took advantage of it.

**Coöperative elevators and warehouses.** The second type of coöperation for business purposes would best be represented by coöperation in providing local rural storage for farm products. This would include elevators for the storage of grains, warehouses for that of cotton, wool, hay, and other farm materials, and cold-storage facilities for poultry, eggs, dairy products and other articles. A group of farmers in Iowa found that they did not have on their home farms sufficient space to store the grain produced, and that they could not afford to build sufficient storage on their farms, since most of the year the building would be empty. It was always very difficult to secure cars at the railway station or siding, and many individual farmers did not have sufficient grain of one kind and one grade to fill a car. The freight was excessive where a part carload was shipped, and the grade was reduced where two grades of grain were mixed in the same car. Many other difficulties and expenses were incurred because it often was difficult to haul the grain just at the right time. Finally, this group of farmers decided to build close to the railroad track an elevator in which the grain could be stored in bins, where it could be cleaned and graded, and from which it could be loaded directly into cars and shipped in carload lots. Each farmer, when he delivered his grain to the elevator, received a receipt stating the amount, kind, and grade of grain. He might immediately sell the grain at the price quoted for that day or he might hold it until a more satisfactory price could be secured. In this case a trained manager was employed, who had charge of the elevator throughout the year. The elevator was built sufficiently large to take care of 50,000 bushels of grain at one time. This, together with the storage on the farms and the fact that full carloads were constantly being shipped, made it possible for the farmers not only to secure better service, but also to secure a higher price without any increase in cost of the finished product to consumers. This elevator company continued to grow and thrive and it has been successfully operated for a great many years. As a result of this first effort, thousands of communities in twenty or more states have organized storage companies, and now elevators and warehouses are to be found scattered over many parts of the United States. This is one of the most successful types of coöperation now carried on by farmers in this country.

**Livestock shipping associations.** The third type of coöperation, which is somewhat different from the two already mentioned, is that form which has to do with the marketing of the products of the farm in their original form. This type probably would best be illustrated by livestock shipping associations, such as those found in some of the north-central states, or lamb clubs, which are a special form found in some of the Appalachian states, or fruit and vegetable (produce) exchanges such as are found in many states. Special forms are found scattered here and there in many corners of the country, such as the strawberry marketing of Kentucky, the organization among farmers in California to market their nuts, etc. These shipping associations and exchanges vary from the temporary local groups of farmers who come together once a year and list their lambs or hogs or livestock and call for sealed bids, after which a sale is completed, to the large, thoroughly organized, permanent exchanges such as the organization among fruit growers in California, or among vegetable growers on the Eastern Shore of Virginia and Maryland. In some cases the marketing organization is perfected even to the point of careful grading, sorting, standardizing, packing, and storage until the market demands the product. Since the method of procedure in all of these cases varies greatly according to the particular type of product to be sold, and according, therefore, to the state or section of the country involved, detailed descriptions might be misleading; and it would be better in each case for farmers interested to communicate with either the college of agriculture of their state or with the office of markets of the United States Department of Agriculture.

Since, in many cases, there is great advantage in changing the form of farm products before selling them, the fourth group would include farmers' manu-

facturing societies or associations. The best illustrations here would be the coöperative creamery, the cheese factory, the canning establishment, etc. In some states, such as Minnesota, the creamery predominates. Here nearly 1,000 communities have already organized in the establishment of local creameries. Farmers with 400 to 600 cows will raise from $4,000 to $6,000 and form a company for the construction and operation of a creamery. Uniformly the farmers themselves subscribe to the stock, even though in some cases they must borrow money in order to purchase their share. They elect officers from their own members, and select their own board of directors. In every case they employ trained buttermakers. So far has this movement proceeded that now these clubs of farmers have state meetings, and a state organization assists in the sale of the product of the local creamery in carload lots to distant markets. In other parts of the country, as in Wisconsin, the cheese factory predominates. Here a smaller number of farmers, with probably half as many cows, will construct a plant costing probably only about half as much as a creamery, and the same general plan of operation is carried out.

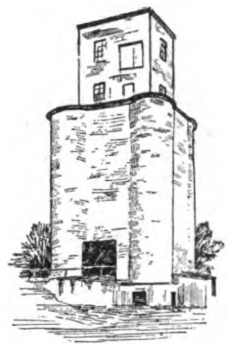


FIG. 68. A thoroughly modern concrete elevator owned coöperatively by Illinois farmers.

**Coöperative purchasing associations.** In this group of coöperative associations for business purposes, there should be included purchasing organizations, such as coöperative supply companies for securing machinery, fuel, fertilizer, feed, seed, and other general supplies needed in the operation of the farm such as spraying materials, packing materials, etc. Probably all of the companies organized for the operation of creameries, cheese factories, etc. purchase their salt, tubs, and other supplies in large quantities to advantage. In the same way the produce exchanges, such as the fruit societies of the West and those selling berries and grapes in the central and eastern states, as well as farmers along the Atlantic seaboard and the South who sell such produce as fruits and vegetables, secure great advantages in the purchase of boxes, barrels, baskets, crates, and other packing materials. In the section where farmers have companies for the operation of elevators and warehouses, the purchase of machinery, fuel, fertilizer, seeds, etc. is common. In some sections of the country where these more complete coöperative organizations do not yet exist, clubs of farmers in thousands of communities have perfected organizations for the purchase of fertilizer and, in some cases, of seed and other farm supplies. These last are the most informal forms of coöperation. In these cases frequently groups of farmers get together once or twice a year to discuss the amount of fertilizer needed and to place consolidated orders for a car or two. Some one member of the club acts as representative of the club to place the order and to notify all the members when the carload has arrived. This member may be paid 50 cents or $1 a ton to look after the work and check out the fertilizer from the cars as each farmer receives his share. Under this plan the farmer who looks after the ordering collects from each farmer and pays the fertilizer company for the entire amount. From the above it will be seen that purchasing societies of many types may be formed, according to the needs of the respective communities and it will also be seen that there already exist literally thousands of more or less definitely and permanently formed organizations for this purpose. Generally speaking, it may be said that this form of coöperation can best be carried on in connection with some of the other forms already referred to.

Closely related to the last-mentioned group comes the more difficult and probably less well-developed purchasing organization for supplying the household requirements of farm families. These organizations are generally referred to as coöperative stores. They are found very extensively in many European countries. In some they are widely known as Rochdale stores. They are also found scattered over the United States, although the number is not yet great. Here a group of farmers must necessarily organize a definite company and subscribe to stock in order to raise funds with which to build or secure the use of a store building, and to purchase the first general consignment of goods of all kinds, ranging from staple groceries through the wider range of boots and shoes and general merchandise. In this case a trained store manager or operator should be employed, and the most successful stores in this country, particularly in the north-central states and on the Pacific Coast, operate much the same as any general store, the difference being that the coöperative store is owned by the farmers and the store manager is employed by them. Where these stores are operated successfully farmers secure their supplies at a greatly reduced cost. Usually they pay regular prices for all of their supplies, but semiannually or annually receive a very substantial dividend in the form of a refund in proportion to the amount of their purchases. In these cases the members expect to receive interest at from 5 to 7 per cent on their money invested, all surplus being distributed in proportion to the amounts purchased.

It would not be proper to pass this phase of the great coöperative movement in farming without, at least, making mention of the great need for and possibilities of coöperation in other ways, if the farms, farm homes, and the community are to be built up and made better in every respect. I have in mind here such forms of coöperation as mutual insurance, the coöperative telephone, and the coöperative societies for purposes of securing credit. In connection with mutual insurance it should be noted that this may be limited to the insurance of farm buildings, or it may be extended to include livestock on farms and also farm crops in storage, such as hay, grain, etc. It will require a much wider organization than a community mutual to provide insurance against destruction of growing crops from hail or other destructive agencies. The same point may be made with reference to organizations for the purpose of securing better rural credit. All facilities are made available for farmers to organize under national supervision to secure long-term land mortgage credit, but farmers may similarly organize for the purpose of securing short-term personal credit for purposes of farm operation. It is important here to note that while the National Government is now prepared to assist farmers in the formation of rural credit associations, it is in no section of the country compulsory, as in the case of the school system. On the other hand, all in one community must belong to one organization, which is in striking contrast to the voluntary organization of churches and Sunday schools.

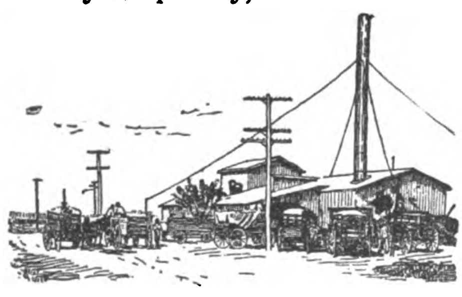


FIG. 69. A farmer's cotton gin. Even in the South, where innovations take root slowly, coöperation is establishing itself firmly and widely.

The entire coöperative movement, not only should have in mind and does have in mind, better farms, better homes, and better communities, as well as better business in farming, but also better local government and with this, in turn, a better state and national government, which means a greater, stronger, more permanent and better democracy.

## How Farmers Can Coöperate

Successful coöperation depends upon the mental attitude of the people who are to become members of the organization. Just as some men are tall and some are short, so it may be said that some are naturally good coöperators and others are not. Each member must be not only willing, but anxious, to give and take. Selfishness must be overcome. The desire to get the best of a neighbor must be eliminated. The motto must, to a very large extent, be, "Each for all and all for each." The greatest success for the organization will be measured by the extent to which the members willingly adopt this motto and actively live up to it. Greater success will come from 10 farmers who have the inclination to coöperate and actively live up to their faith than from an organization of 20 farmers, each suspicious of the other's good intentions and willing or anxious to take advantage of the other, if an opportunity presents itself.

In any community the meeting of the minds of the people must be the starting point of coöperative organization. All must agree as to which is the most important, most practicable, and most useful form of coöperation for the community. After this question has been settled, and after a sufficient number of neighbors have become sufficiently acquainted to be sure that the coöperative mind or attitude is present, the actual organizing—the drawing up and adopting of articles of incorporation, constitution, and by-laws, and, finally, of rules and regulations for the government or management of the enterprise—all this is an easy matter. A letter to any college of agriculture, or to the Department of Agriculture at Washington, D. C., will bring sample copies of forms which may be used almost without change. Many collections have been made of forms which have been successfully used in hundreds of communities and these need not be reproduced here. Several good books on coöperation among farmers are available, some of which carry all necessary forms, blanks, sample constitutions, etc.

**Organization should not be rushed.** It is more important to devote weeks, even months, or a year or two, to the task of organizing and perfecting plans than to try to rush through these plans hastily and imperfectly at one brief meeting, in order to engage quickly in some form of coöperative enterprise. Probably more failures are due to haste in preparation than to any other cause. Too often a group of neighbors, called together on the spur of the moment, adopt something which is read, and immediately wish to see results. Unless they secure very large returns within the first few months, some are disappointed and fall by the wayside, others become discouraged and commence to complain. From years of experience, study, and observation, it is now positively established in my mind that patience, forbearance, and perseverance—all of which mean willingness to go slow and to lay a solid, permanent, and thorough foundation—are the fundamental necessities, if great results are to be secured in the long run.

Coöperation in farming for business purposes shows signs of 2 conflicting movements. Some forms of coöperation have for their aim the bringing back to the farmers of some of the work which they formerly had and which was taken away from them by the development and centralization of industrial enterprise; other forms aim to relieve the individual farm or farmer of tasks which he can clearly not perform most successfully or most economically. In the case of coöperative elevators, for instance, success is based upon the fact that individual farmers cannot most successfully or economically store their products on their own farms preliminary to placing them upon the market.

At the same time, it is based upon the confident belief that farmers can and should retain control and ownership of their products until the best time for marketing arrives. In other words, it is based upon the established belief that a better market can be secured and better prices received, if farmers do not immediately sell the products on their farms to outside parties, but rather that, if they will hold their products until the market is ready, more satisfactory results will be secured. The success of the coöperative creamery, cheese factory, cannery, etc. is based upon the well-established principle that the manufactured product—butter, cheese, canned vegetables, etc.—will be more uniform, better prepared, if made in a small local factory, than it will be if made on individual farms or even in great central establishments.

The whole success of the great new movement of coöperation in farming will be based upon successful analysis of the best form of organization in each case. In the matter of flour milling, meat packing, cloth making, etc., it will probably prove true in the long run that large central establishments are more economical and more efficient than small local establishments close to the farm. The larger central establishments will probably produce more cheaply and produce a better article and at the same time bring the finished product to the consumers at a lower price. In the matter of making butter, cheese, canned goods, etc. on the other hand, the local establishment, locally formed and operated, will probably be the more successful. This is all the more reason why time should be taken in each case in definitely determining the best program for each community.

**Management of coöperative associations.** As has been frequently said, what is everybody's business is nobody's business, and one of the first matters to be definitely decided by any group of farmers is the matter of management. The election or selection of officers and a board of directors for the new organization is one matter. These should be selected from the members themselves; and, in order to maintain a wise program, the membership should keep constantly advised of all details of organization and operation, and reasonable rotation in officers and directors among the members is desirable. All work by directors and officers, except in very special cases, should be performed without compensation. This is all the more reason why all members should actively interest themselves and why there should be reasonable rotation in office. This does not mean that a completely new board of directors and a completely new set of officers should be selected each year. Perpetuation of the organization demands gradual changes in office.

The employment of paid clerks, laborers, and a manager is a separate and distinct problem, and should be worked out with care. Probably the second great cause for failure of business coöperation in the past has been failure to understand the importance of this point. While officers and directors should be secured from members at all times, paid employees should be selected exclusively with one thought in mind—efficient operation of the new enterprise. If a creamery is to be established, a trained, experienced butter-maker should be employed; also, in the case of a cheese factory, a canning establishment, or an elevator for storage purposes, and so on. Just as a man cannot learn to do certain things successfully in a day, or a year, or even 5 years, so, too, the employees cannot be trained to do their special work efficiently in a few months or a year. Therefore, as far as possible, employees already trained in the work should be secured. In this same connection, whereas there should be reasonable rotation in office among directors and officers, this does not apply to such employees as clerks, laborers, and managers. Once a trained and efficient employee has been secured, he

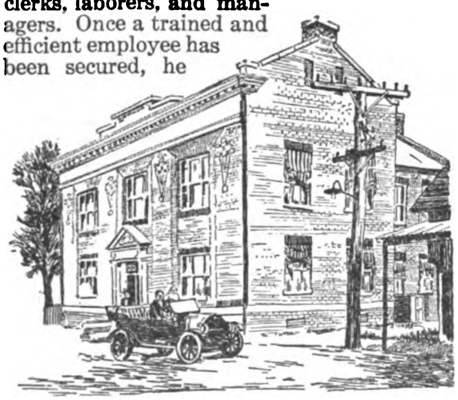


FIG. 70. The home office of the Eastern Shore of Virginia Produce Exchange, a vegetable growers' coöperative organization which has achieved noteworthy success. (U. S. Bureau of Markets.)

should be retained almost at any cost. Efficiency should be compensated to the limit; in other words, wages and salaries should be commensurate with labor performed. Too often a club of farmers organizing a coöperative association feel that it is good policy to employ one of their own members to manage the same. He, however, may not be trained in the special work to be done, and failure results. Again, a group of farmers decide to distribute employment by employing one member one year, another member a second year, and so on. This is even worse, since when one man has become proficient, he is dropped out and another untrained man is put in his place.

Coöperative organizations should be put on a definite business basis. This means definite bookkeeping and permanent records of all transactions, and, also, that if the manager employed has to handle any considerable amount of funds, he should be properly placed under bond to protect both himself and the organization. In addition, there should be regular quarterly, semiannual, or annual auditing of all books and accounts. This is only fair to the manager, and is necessary in order that the members may know constantly that good business methods are being followed. No other one thing will so entirely remove suspicion and eliminate doubt as an auditing by a trained specialist. Many a coöperative association falls to pieces as the result of unjustifiable criticism, doubt, fear, or lack of confidence on the part of some of its members. Even if there are only 25 members, it will be good business for them to contribute $1 each year for the employment of a trained auditor, or to set aside from the surplus a reasonable amount to pay for the inspection of the records.

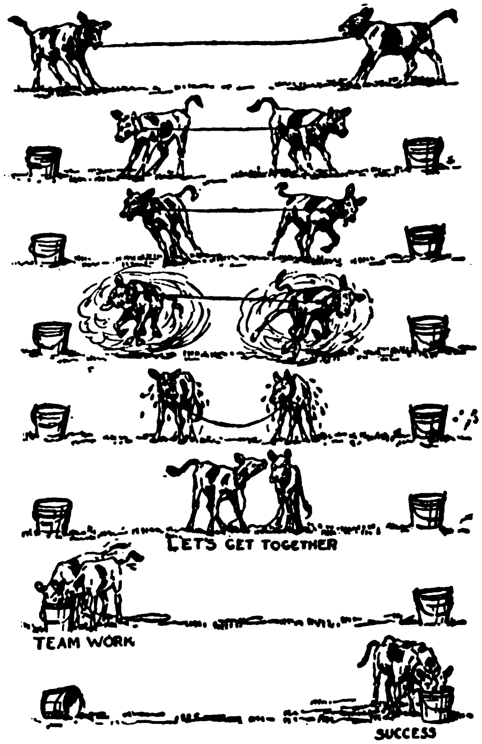



FIG. 71. A cartoon—of which the original source, being unknown, cannot be credited—which illustrates with both humor and accuracy the possibilities of coöperation.

Coöperation in farming has come to stay in America. The first great struggle was the organization on a democratic or coöperative basis of the government of the nation and its smaller communities. Following this came the development and perfection of voluntary coöperation in the establishment of our great system of churches and Sunday schools. Following these evidences of coöperation came the agreement on the part of the great masses of the people to establish a great school system. Gradually there developed from this the great movement for the establishment of roads, bridges, etc., which, also, is now all but universal.

It is not surprising that other great types of coöperation should be slow in developing; but that they are developing is evidence of the success and approval of their predecessors. They are rapidly increasing in number, improving in organization, and proving their value by standardizing products, by securing better markets, and in other ways by rendering service, not only to their members but to society at large. It may be many years before even a majority of all of the farmers in America will belong to one or more coöperative organizations. But here we should remember that the world has waited long for this great introduction of democracy in business; for, after all, coöperation is only a form or manifestation of the principle of democracy.

FIG. 72. A lookout station of the U. S. Forest Service in the mountains of the Southwest. (U. S. Forest Service.)

# CHAPTER 7

# The Farmer and the Law

*By* MRS. NELLIE E. FEALY, *of the United States Department of Agriculture, who has been a member of the staff of the Bureau of Plant Industry of that Department since its organization. For several years Mrs. Fealy has been making a special study of a wide range of agricultural laws, and is the author of a Monograph on the Organization in the United States for Dealing with Plant Diseases and Plant Pests, which deals largely with laws affecting the farmer; also of a bulletin on the laws and quarantines affecting importation and interstate movement of nursery stock.*

*There is a widespread tendency to think of law entirely as something prohibitive, something that limits the freedom of a person's actions. The truth is that laws are enacted mainly to safeguard and benefit the many, by establishing limits beyond which the few, willfully or unscrupulously, tend to go. Thus every farmer who is doing a legitimate business should feel that the quarantines, regulations, restrictions, etc., that in any way affect his activities are designed first of all to help him and to protect him from dishonest competitors, and careless, ignorant, or evilly disposed fellow farmers. Because the state and Federal governments may be centered far from his farm, is no sign that the laws they make are not just as individual, just as carefully thought out, and just as applicable to his conditions as those made by the authorities of his immediate neighborhood. Because they are not represented by uniformed police, is no sign that they are not just as important and just as active. On the contrary, indeed, the law, whether of village, town, county, state, or nation, is the farmer's friend, and as such deserves his sympathy and support. And that he may give it intelligent sympathy and support he should also have a knowledge of what the law is, and what it does, and how it does it.*—EDITOR.

THE Federal Government and the various states have numerous laws which affect the farmer directly or indirectly. In many cases both have laws on the same subjects; in some cases certain states have laws on subjects on which there is no national legislation, such as fertilizers, weeds, dairying, and certain questions pertaining to stock; and in still other cases the Federal statutes are not duplicated by those of the states, as in grain and cotton standardization, and some questions regarding land and irrigation and drainage.

The farmer is generally more familiar with the laws of his immediate locality and his state than with the Federal laws. However, the former are binding only on the citizens of such locality or state, and differ from those of other states and localities, whereas the laws of the Federal Government are binding on all citizens of the United States. Since all laws relating to any one subject have practically the same objects and are based on the same principles, the Federal laws will be discussed here to show the relation of the farmer to law as a whole.

Federal legislation, as it relates to agriculture and agricultural interests, may be divided into seven classes, namely: general, educational, investigational, extension, regulatory, constructional, and financial.

## General Legislation in Behalf of Agriculture

As agriculture developed in this country, there likewise developed the necessity of a Government clearing house, so to speak, for this branch of national industry. This resulted in the passage and, on May 15, 1862, the approval of the

**ACT CREATING THE UNITED STATES DEPARTMENT OF AGRICULTURE.** The Department carries on investigational, extension, and regulatory work, and includes within its scope practically every known phase of every agricultural problem with which the farmer has to deal. It is divided into 16 branches, each of which is made up of a number of divisions which may be briefly described as follows:

1. **The Office of the Secretary.** The Secretary of Agriculture has general charge of the affairs of the Department, aided by an Assistant Secretary and a Director of Scientific Work. This branch includes the Office of the Solicitor, which has charge of the law work of the Department, and the Division of Publications, motion-picture service, and press service, which through agricultural and other papers, and by means of pamphlets, circulars, and posters, places in the hands of farmers, in simple and understandable form, helpful information obtained by the Department's scientists, specialists, and field workers through their studies, investigations, and experiments.

2. **Weather Bureau.** The agricultural phase of this Bureau's work consists of forecasting the weather; displaying storm, cold-wave, frost, and flood warnings; furnishing information useful in connection with water for irrigation, relation of weather to crops, and effects of current weather conditions on important crops; determining the history of the climate of the various sections of the country; sending out special warnings for the growers of certain crops; and maintaining special stations in connection with the most important crops. Its stations number in all about 200.

3. **Bureau of Animal Industry.** Conducts work with livestock and poultry and their food products, and is charged with the enforcement of the laws regarding the control of diseases of livestock (p. 100); proper treatment of livestock in interstate traffic (p. 105); meat inspection (p. 105); the handling of oleomargarine and process or renovated butter (p. 105); and the manufacture and distribution of viruses, serums, and toxins (p. 102). Besides the assistance rendered the farmer through the enforcement of the laws mentioned, the Bureau aids him by improving his livestock by scientific breeding; feeding livestock and poultry more economically and with better results; deciding the best sections of the country in which to carry on the different branches of the livestock industry and the animals best adapted to the various sections; improving and caring for dairy and poultry products; improving stock feeds, silos, and sanitary conditions in connection with livestock; organizing in the interest of better methods and increased production; and controlling pests and diseases of livestock and poultry.

4. **Bureau of Plant Industry.** Studies plant life in all its relations to agriculture, and enforces the seed importation act (p. 101). It aids the farmer by working out means for controlling diseases of his crops; determining the best crops and best varieties for different sections and conditions; producing and distributing free of charge improved and valuable varieties of seeds and plants, and strains resistant to diseases and insects and with increased resistance to drought; increasing the fertility of the soil through improved methods of cultivation, cropping, rotation, and the use of fertilizers and of nitrogen-fixing bacteria, which it distributes free; examining and testing commercial seeds in order to prevent the use of impure seed; determining the best methods of growing crops in semiarid regions; developing profitable agriculture for lands in the West to be placed under irrigation, and determining what crops can be profitably grown under irrigation; improving methods of growing, preparing, and shipping perishable fruits and vegetables; assisting in establishing agricultural industries or reclamation projects; and bringing in seeds and plants from all parts of the world, and establishing new domestic plant industries. It has charge of the Congressional seed distribution.

5. **Forest Service.** Has charge of the national forests; studies forest conditions and utilization problems; investigates properties of woods and manufacturing processes; and ascertains the needs of wood-using industries and the relation of the forests to the public welfare.

It aids the farmer and the nation at large by (1) controlling forest fires, thoroughly organized forces and the necessary equipment for dealing with these fires being maintained in the different national forests—in coöperation with the War Department it maintains an air patrol of certain Western national forests; (2) arranging with owners for the grazing of livestock on forest ranges; (3) determining methods of improving and protecting the ranges from overgrazing; (4) protecting stock against poisoning from certain plants, and destroying such plants on ranges; (5) determining best methods of handling stock under range conditions and of developing and distributing stock watering places on the ranges; (6) re-

FIG. 73. A Forest Service lookout in a heavily timbered region. The Government not only makes and enforces laws, but also helps the farmer to abide and profit by them.

foresting national forest areas, the necessary nurseries for producing planting stock for this purpose being maintained; (7) determining the relation of forestry to climate and stream flow; (8) determining the best methods of range management, the reseeding of the range, and prevention of erosion in mountain meadows; (9) improving practices in the handling of woodlots and marketing of woodlot products; (10) destroying in national forests animals which prey upon livestock; (11) classifying and setting apart lands in the national forests that may be opened for settlement and entry under the homestead laws; and (12) under the Federal Road Act (p. 107), coöperating with state and local authorities in building and repairing roads, trails, and bridges in the national forests, in order to open new territory to settlement and provide settlers with means of communication and transportation. The service includes the Forester's Office, 7 branches, 8 districts, and 152 national forests.

6. **Bureau of Chemistry**. The work of this Bureau is mainly agricultural chemistry and the enforcement of the Food and Drugs Act (p. 105). It aids the farmer through investigations and experiments in the feeding of farm animals and plants; investigations and experiments to determine the best fungicides and insecticides; studies in the drying of fruits and vegetables; conservation of surplus fruit and vegetable products; and investigations to determine the causes of dust explosions in mills and factories.

7. **Bureau of Soils**. Studies the relation of soils to climate and organic life and the composition and texture of soils; makes soil surveys in different parts of the country; investigates fertilizer resources and new materials for use as fertilizers; and works out methods for improving the manufacture of fertilizers.

8. **Bureau of Entomology**. Studies beneficial and injurious insects, works out means of controlling injurious species, and tests spraying machinery. As a result, the farmer is saved vast amounts annually through the control of insect pests of plants and animals, his own health is safeguarded against diseases carried by the mosquito and the house fly, and practices in connection with the bee industry are improved.

9. **Bureau of Biological Survey**. Conducts work with wild birds and mammals, makes biological surveys, supervises national big-game and bird reservations, and enforces the law to prevent the importation of birds and mammals injurious to the farmer (p. 101), the law for the protection of migratory birds (p. 102), and the Convention between Great Britain and the United States for that purpose (p. 102). It aids the farmer by working out methods for protecting birds and mammals that are useful and for controlling those that are harmful to his crops and stock, and by coöperating with State and local authorities in destroying injurious mammals.

10. **Bureau of Agricultural Economics**. Helps the farmer to dispose of his products to the best advantage by determining local and foreign demand and supply; by working out improved methods of grading, standardizing, packing, and shipping; and by sending out daily reports of shipments and prices of certain fruits and vegetables during their respective market seasons, publishes information regarding the condition of the principal crops and probable yields and prices; and aims to introduce better business methods and improved farm practices. It enforces the Grain Standards Act (p. 106), the United States Cotton Futures Act (p. 106), the Warehouse Act (p. 106), the Standard Basket Act (p. 106), the act to authorize association of producers of agricultural products (p. 105), the packers and stockyards act (p. 106), and the act taxing contracts for sale of grain for future delivery (p. 107).

11. **States Relations Service**. Establishes and maintains proper relations between the Department and the agricultural colleges and experiment stations; conducts the experiment stations in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands; carries to the farmer, in coöperation with the state agricultural colleges, the discoveries and improvements worked out by the Department, and teaches him through county and state agents how to use this information in improving his land and his crops and livestock, how to prevent or control diseases attacking plants and animals, how to increase his yields, and how best to handle his farm products; works out improved methods of conducting movable schools of agriculture and farmers' institutes, etc., and furnishes these organizations with helpful reading and illustrated matter; aids agricultural schools in their work; and discharges the duties of the Department created by the Morrill Act (p. 99), the Hatch Act (p. 99), and the Smith-Lever Act (p. 100).

12. **Bureau of Public Roads**. Determines the best materials for use in road building; aids state and county officials in the construction and upkeep of roads; determines the best

dust preventives; builds rural post roads in coöperation with the states, and builds and keeps up roads and trails in national forests in coöperation with the states and the Forest Service; determines the best methods of disposing of sewage on the farm; works out improvements in irrigation methods; helps farmers in connection with farm irrigation, drainage, building construction, machinery, and engineering; and enforces the Federal Aid Road Act (p. 107.)

13. **Division of Publications.** Distributes through publications and its press service the helpful information obtained by the Department's workers.

14. **Insecticide and Fungicide Board.** Enforces the Insecticides Act of 1910 (p. 101).

15. **Federal Horticultural Board.** Enforces the Plant Quarantine Act (p. 101).

16. **Miscellaneous.** Efforts are being made to promote commercial livestock raising in the cane-growing and cotton districts, and dairying and livestock production in semiarid and irrigated sections.

## Educational Legislation for the Farmer

After the establishment of the Department, the next step was logically to help the farmer secure an agricultural education. This was undertaken through two acts, as follows:

**THE MORRILL ACT.** This was passed by Congress July 2, 1862, and is administered by the Secretary of the Interior through the Bureau of Education. Under it the Government donated to each state public lands at the rate of 30,000 acres for each of its Senators and each Representative (according to the census of 1860) to create a perpetual fund for use in establishing and maintaining at least one college which shall teach especially, but not exclusively, "such branches of learning as are related to agriculture and the mechanic arts." Later legislation provided further endowments, until now each state receives an annual appropriation of $50,000 for the purpose.

Under this legislation 68 institutions are now offering courses in agriculture. There is one in each state and in Porto Rico and Hawaii, and 16 of the states have 1 additional, and one state has 2 additional institutions for colored students.

**AN ACT to provide for vocational education.** This was approved Feb. 23, 1917, and is administered by a Federal Board of Vocational Education created by the act, and consisting of the Secretaries of Agriculture, Commerce, and Labor, the United States Commissioner of Education, and 3 citizens appointed by the President and approved by the Senate, to represent commerce and manufacturing, agriculture, and labor, respectively.

The act appropriated for the paying of salaries of teachers, etc., of agriculture $500,000 for the year ending June 30, 1918, and gradually increases the amount each year for 7 years, after which it is $3,000,000 annually; it makes separate appropriations for paying the salaries of teachers of trade, home economics, and industrial subjects; and appropriates for coöperation with the states in preparing teachers, etc., $500,000 for the year ending June 30, 1918, $700,000 and $900,000 for the two succeeding years, and $1,000,000 for each year thereafter.

Before any state may receive these appropriations, it must designate a Board of not less than 3 members to coöperate with the Federal Board and prepare and submit for its approval plans showing the proposed kind of vocational education, the kinds of schools and equipment, course of study, methods of instruction, qualifications of teachers and of supervisors or directors in the case of agricultural subjects, and plans for training teachers, and in the case of agricultural subjects, plans for supervision of education.

The appropriations are allotted on the basis of population, and should those of any state become diminished or lost they must be replaced by it.

## Investigational Legislation Concerning Agriculture

The agricultural colleges taught the theories of the various sciences connected with agriculture, but fell far short of their objectives and possibilities until supplemented in 1887 with facilities for carrying on original research and experimental work through what is known as

**THE HATCH ACT.** This act, approved March 2, 1887, provides for establishing, under the direction of the agricultural and mechanical college or colleges in each state, an agricultural experiment station. The duty of these stations is "to conduct original researches or verify experiments on (1) the physiology of plants and animals; (2) the diseases to which they are subject, with the remedies for same; (3) the chemical composition of useful plants at the different stages of growth; (4) the comparative advantages of rotative cropping; (5) the capacity of new plants or trees for acclimation; (6) the analysis

of soils and water; (7) the chemical composition of manures, and the comparative effects on crops of different kinds; (8) the adaptation and value of grasses and forage plants; (9) the composition and digestibility of the different kinds of feed for domestic animals; (10) scientific and economic questions involved in the production of butter and cheese; and (11) all such other researches or experiments bearing directly on the nation's agricultural industry as may be deemed advisable.

Under this act and later legislation, each state now receives annually $30,000. The stations also receive state funds, but these total less than the amount contributed by the Federal Government.

Besides the experiment stations in the states, there is one each in Alaska, Hawaii, Porto Rico, Guam, and the Virgin Islands conducted by the States Relations Service.

## Extension Legislation for the Farmer

Notwithstanding the great activity of the agricultural colleges, they could not, for one reason or another, reach many, and comparatively few could come to them. Moreover, the experiment stations and the Department were accumulating much agricultural information, and the necessity of getting it before the farmer and teaching him how to apply it on his farm were serious problems until solved in 1914 by

**THE SMITH-LEVER ACT**. This was approved May, 4, 1914, and provides that agricultural extension work shall be carried on in coöperation with the U.S. Department of Agriculture by each of the state colleges of agriculture benefiting by the Morrill Act and supplementary legislation.

Under it $480,000 is appropriated annually to meet the necessary expenses of the work; and there is further appropriated for the second fiscal year $600,000, and for each fiscal year thereafter for 7 years an additional $500,000, or at the end of the period $4,100,000 annually besides the original $480,000.

All but the latter are allotted annually to each state in the proportion that the rural population of each bears to the total rural population of all the states (Federal Census figures) but no such payment is made in any year until an equal sum has been appropriated for that year by the state legislature, or provided from some other sources within the state. No appropriation for any year becomes available until a college submits its plans for the work to and secures the approval of the Secretary of Agriculture.

## Regulatory Legislation Affecting the Farmer

With the development of agriculture the necessity of regulatory legislation along certain lines also developed and resulted in many laws affecting rural interests. The facts that no policemen are stationed on the farm, and that the provisions of these laws are usually enforced elsewhere than on the farm, show that they are intended, in most cases, primarily for the benefit of the farmer. This class of laws may be divided into 2 groups: (1) those which affect the farmer directly and pertain mainly to material going to or already on the farm; and (2) those which affect the farmer indirectly and pertain mainly to farm products after they have left his hands. The following more important and widely applicable Federal statutes illustrate their general nature:

## Laws Directly Affecting the Farmer

**AN ACT for the control of diseases of livestock.** This act, approved May 29, 1884, and supplemental acts of 1903, and 1905, are designed to stamp out, and to prevent the introduction and spread of contagious, infectious, and communicable diseases. No animal affected with such disease may be exported, placed in interstate traffic, or driven or taken to or from any state or territory or the District of Columbia. To enforce the act, the Bureau of Animal Industry maintains a large number of inspection stations throughout the country.

An amendment approved May 31, 1920, provides that cattle which react to the tuberculin test may under conditions be moved in interstate commerce for immediate slaughter or be reshipped to the original owner.

When the Secretary deems it necessary to destroy tubercular animals and indemnify the owner for their loss, he may use Federal funds within limits for the purpose, but such indemnity must be made in coöperation with

and supplementary to indemnities by the State or locality in which the condemnation took place.

**THE LACEY ACT,** approved May 25, 1900, prohibits the importation into the United States or any territory or district thereof, of the mongoose, "flying fox," or fruit bat, English sparrow, starling, and such other mammals and birds as may from time to time be declared injurious to the interests of agriculture or horticulture, and provides that whenever any of these arrive at a port of entry they must be destroyed or returned at the owner's expense. Except in the case of natural history specimens for scientific collections, cage birds, and such other birds as the Secretary of Agriculture may designate, no foreign wild mammal or bird may be imported except under special permit.

This act also prohibits the transportation and delivery of any foreign mammal or bird, the importation of which is prohibited, or of dead bodies or parts of wild mammals or birds killed or shipped in violation of local laws.

**INSECTICIDES ACT OF 1910.** This act, approved April 26, 1910, aims to prevent the manufacture and sale of insecticides and fungicides that are adulterated or misbranded.

Samples for examination are collected, in accordance with uniform rules, by regularly appointed official sample collectors acting under the supervision of the Insecticide and Fungicide Board, and are examined in the Department of Agriculture.

Should examination show that the article is adulterated or misbranded, the Secretary of Agriculture is required to give the party from whom the sample was obtained opportunity to be heard. If thereafter it still appears that the act has been violated, the Secretary is required to refer the case to the proper United States Attorney, who is required to commence proceedings in the proper United States court.

Goods alleged to be in violation of the law may be seized and, if condemned by the court, they may be destroyed or sold, as the court may direct, the net proceeds going into the treasury of the United States; or the goods may be delivered to the owner in case he furnishes an acceptable bond to the effect that they will not be sold or disposed of contrary to law.

The Secretary of the Treasury is required to furnish the Secretary of Agriculture, on his request, samples of articles covered by the act which are being imported or offered for import into the United States. If any such article is shown to be in violation of the law, it is refused admission, and is destroyed unless exported by the consignee within 3 months.

**THE PLANT QUARANTINE ACT.** The purposes of this act, approved August 20, 1921, and amended March 4, 1913, March 4, 1917, and May 31, 1920, are "to regulate the importation of nursery stock and other plants and plant products; to provide for establishing quarantines and quarantine districts for plant diseases and insect pests; to permit and regulate the movement of fruits, plants, and vegetables therefrom," etc.

Under this act it is unlawful to import nursery stock, that is, "field-grown florists' stock, trees, shrubs, vines, cuttings, grafts, scions, buds, fruit pits and other seeds of fruit and ornamental trees or shrubs, and other plants and plant products for propagation, except field, vegetable, and flower seeds, bedding plants, and other herbaceous plants, bulbs, and roots," or to offer it for entry into the United States unless a permit therefor has been issued by the Secretary of Agriculture. In case the stock is imported from a country in which a system of plant inspection is maintained, it must also be accompanied by a certificate of inspection from the proper official of that country showing that it has been thoroughly inspected and is believed to be free from injurious diseases and insect pests. If imported from a country in which no system of plant inspection is maintained, it may be brought in under such conditions and regulations as the Secretary of Agriculture may prescribe.

Under this act more than 50 foreign and domestic quarantines are being or temporarily have been enforced. The most important is a nursery-stock, plant, and seed quarantine, effective June 1, 1919, which provides that plant products intended for medicinal, food, or manufacturing purposes, and field, vegetable, and flower seeds, may be imported without permit or other restrictions; that certain specified classes of plants may be imported for propagation under permit upon compliance with other of the regulations; and that the entry of plants or plant products not specifically provided for in certain designated regulations, from any foreign source is restricted to importations by the United States Department of Agriculture for experimental or scientific purposes.

The Secretary of Agriculture is authorized and directed to quarantine any state, territory, or district of the United States or any part thereof when in his judgment such quarantine is necessary to prevent the spread of any dangerous plant disease or insect pest not hitherto widely prevalent or distributed throughout the United States, but before doing this he must give a public hearing.

After such quarantine is established no plant or plant material specificd may be offered for shipment to any common carrier, or received or transported by such carrier except in accordance with the regulations governing the inspection, disinfection, certification, and manner and method of delivery and shipment.

**THE SEED IMPORTATION ACT.** This act, approved Aug. 24, 1912, together with

FIG. 74. Forest rangers inspecting cattle that are being turned into the pastures of a National forest. Precautions and preparations are large factors in successful lawmaking and the preservation of law and order. (U. S. Forest Service.)

supplementary legislation, prohibits the importation of seed of alfalfa, barley, Canadian bluegrass, Kentucky bluegrass, awnless brome grass, buckwheat, clover, field corn, Kafir corn, meadow fescue, flax, millet, oats, orchard grass, rape, redtop, rye grass, rye, sorghum, timothy, wheat, vetches, and mixtures of seeds containing any of these seeds as one of the principal parts, when adulterated or unfit for seeding purposes. The seeds and mixtures mentioned may, however, be delivered to the owner or consignee in bond to be recleaned according to regulations prescribed by the Secretary of the Treasury. When cleaned to conform to the following standards of purity, and when the screenings and other refuse are disposed of as required by the Secretary of Agriculture, the seed or mixture may be released.

Under the law, red clover seed is considered adulterated when it contains more than 3 per cent by weight of yellow trefoil or other seed resembling, but of lower market value than, red clover; alfalfa seed, when it contains more than 3 per cent by weight of seed of trefoil, bur clover, and sweet clover singly or combined; and any other kind, variety, or mixture (except mixtures of white and alsike clover, red and alsike clover, or alsike clover and timothy) when they contain more than 5 per cent by weight of other seed of similar appearance but lower market value.

Seed is considered unfit for seeding purposes when any kind, variety, or mixture contains less than 65 per cent of live pure seed as distinguished from dead seed, chaff, dirt, or other seeds or foreign matter, *except* Kentucky bluegrass and Canada bluegrass seed, which may contain not less than 50 per cent of live pure seed.

This act does *not* apply to the importation of barley, buckwheat, field corn, Kafir corn, sorghum, flax, oats, rye, or wheat not intended for seeding purposes.

**THE VIRUS - SERUM - TOXIN ACT.** This act, approved March 4, 1913, is designed to protect the farmer against worthless, harmful, contaminated, or dangerous viruses, serums, toxins, and other substances intended for use in the treatment of domestic animals, by prohibiting their manufacture, importation, and sale unless they conform to rules and regulations made by the Secretary of Agriculture. Each manufacturer of such articles must obtain a license and have his plant approved by the Bureau of Animal Industry, which also examines samples of all viruses, serums, and toxins imported or to be imported. Unless they conform to the requirements, they are refused entry.

**MIGRATORY BIRD LAW.** This law, approved March 4,1913, places in the custody and under the protection of the Government all migratory game and insectivorous (insect-eating) birds which do not remain permanently within the borders of any state or territory. Such birds are the bobolink, catbird, chickadee, cuckoo, flicker, flycatcher, grosbeak, hummingbird, kinglet, martin, meadowlark, nighthawk or bull bat, nuthatch, oriole, robin, shrike, swallow, swift, tanager, titmouse, thrush, vireos, warbler, waxwing, whippoorwill, woodpecker, and wren, and all other perching birds which feed entirely or chiefly on insects.

The closed season extends throughout the entire year for all insectivorous birds except reedbirds or rice birds, the closed season for these in New Jersey, Pennsylvania, Delaware, Maryland, District of Columbia, Virginia, North Carolina, South Carolina, and Georgia extending from November 1 to August 31, inclusive. However, any insectivorous bird may be collected under permit at any time for scientific purposes in accordance with the state laws.

To protect these birds, the regulations provide a breeding zone and a winter zone. The former comprises 30 states, namely: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Kentucky, West Virginia, Michigan, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska, Kansas, Missouri, Colorado, Wyoming, Montana, Idaho, Utah, Nevada, Oregon, and Washington. The latter includes the District of Columbia, and the following 17 states: Delaware, Maryland, Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Arkansas, Louisiana, Texas, Oklahoma, New Mexico, Arizona, and California.

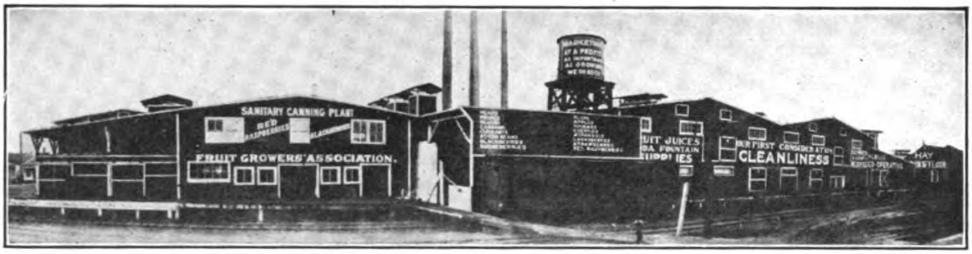
**CONVENTION between Great Britain and the United States for the protection of migratory birds.** This was entered into, ratified, and proclaimed by the President in 1916. Its provisions, so far as the United States is concerned, are administered through the Bureau of Biological Survey. Included under its terms are migratory game birds, migratory insectivorous birds, and other migratory nongame birds, many species of which traverse certain parts of Canada and the United States.

The public sale is a popular and profitable method of advertising a purebred livestock business


The farmer should be alive to every legitimate means of making himself and his products known and their quality appreciated


Direct retail marketing opens a way to much valuable publicity

THE SUCCESSFUL FARMER MUST BE A GOOD ADVERTISER, WITH SOMETHING GOOD TO ADVERTISE




A coöperative canning plant developed by a marketing association to handle its surplus fruit and other produce. (U. S. Bureau of Markets)

A rural coöperative fruit and vegetable market in which "no commissions" is the rule. (American Coöperative Journal)


A farmers' coöperative store that did a business of $16,000 the first six months, paying a capital stock dividend of 6 per cent, and a purchase dividend of 10 per cent. (American Coöperative Journal)

**Coöperative Marketing Takes Various Forms But Almost Invariably It Pays**

The provisions are of direct interest to the farmer as they relate to insectivorous birds (those listed in the Migratory Bird Law above).

The closed season on migratory insectivorous birds continues throughout the year, and the taking of their nests or eggs except for scientific or propagating purposes is prohibited in accordance with such laws or regulations as the Contracting Powers may deem necessary.

International traffic in insectivorous birds or their eggs is prohibited, except for scientific purposes; such shipments between the United States and Canada must be marked plainly with the name and address of the shipper and nature of the contents.

Should any insectivorous bird become seriously injurious to agricultural or other interests in any particular community, the proper authorities of the High Contracting Powers may issue permits to kill such birds under certain regulations during the emergency. Birds killed under such permits may not be shipped, sold, or offered for sale.

The terms of the Convention continue in force until 1932, and, unless 12 months' notice of intention to terminate its operations is given by either of the High Contracting Powers before the expiration of the 15 years, the Convention will continue one additional year, and so on from year to year thereafter. An act giving effect to this Convention was approved July 3, 1918.

## Laws Indirectly Affecting the Farmer

**AN ACT to authorize the association of producers of agricultural products.** Under this act, approved February 18, 1922, persons engaged in producing agricultural products may act in associations, corporate or otherwise, in collectively processing, handling, and marketing the products in interstate and foreign commerce, and may have marketing agencies in common, provided that such associations are operated for the mutual benefit of the members as producers. No member shall have more than one vote, regardless of amount of stock or membership capital possessed; dividends on stock or capital may not be paid in excess of 8 per cent per annum; and an association may not deal in products of nonmembers to an amount greater in value than the amount it handles for members. Should an association monopolize or restrain trade to such an extent that the price of any agricultural product is thereby increased, the Secretary of Agriculture serves a complaint and if this is sustained by evidence at a hearing within 30 days, he serves notice on the association to desist from the monopolization or restraint of trade within 30 days.

**OLEOMARGARINE ACT.** This act was approved Aug. 27, 1886, and amended in 1890 and 1902. Its object is to protect the public from imposition through the manufacture and sale of oleomargarine and process or renovated butter. It makes oleomargarine and any other imitation dairy product shipped into any state, territory, or the District of Columbia subject to its laws; fixes the taxes to be paid by manufacturers and importers of, and wholesale and retail dealers in, oleomargarine or process or renovated butter, and the taxes on oleomargarine artificially colored in imitation of butter; and fixes the requirements regarding the size and kind of containers and stamping and labeling.

**THE FOOD AND DRUGS ACT.** This act, approved June 30, 1906, aims to protect the health of, and prevents imposition on, the public by prohibiting the manufacture and sale of adulterated or misbranded or poisonous or deleterious foods, drugs, medicines, and liquors, and interstate commerce in them. Whenever a farmer ships his products direct from the farm into or through another state, or sells them within the District of Columbia, he is subject to the provisions of the act.

**MEAT INSPECTION ACT.** This act, approved June 30, 1906, aims to protect the health of, and prevents imposition on, the public, including the farmer, by prohibiting the use in interstate and foreign commerce of meat and meat food products which are unsound, unhealthful, unwholesome, or otherwise unfit for human food.

**AN ACT to prevent cruelty to animals in interstate traffic.** This act was approved June 29, 1906, and supplemented by another approved in 1913. Every animal in interstate traffic confined in any common carrier in which there is not proper food, water, space, and opportunity for rest, must be humanely unloaded into proper pens at intervals of not to exceed 24 hours, unless this is impossible, or 36 hours under certain conditions, and fed, watered, and rested during a period of 5 consecutive hours. In the case of sheep, it is not required that they be unloaded at night to keep within the 24-hour time limit, but they must be unloaded within 36 hours.

**AN ACT to establish a standard barrel and standard grades for apples packed in barrels.** This act, approved Aug. 3, 1912, is administered by the Bureau of Standards. The dimensions of the standard barrel as provided by it are: Length of stave 28½ inches, diameter of head 17⅛ inches, distance between heads 26 inches, circumference of bulge 64 inches, outside measurement; these represent as nearly as possible 7,056 cubic inches. In the case of steel barrels the interior dimensions are to be as given. The act also fixes the standard grades for apples packed in barrels for interstate or foreign commerce and sets forth requirements regarding branding.

**AN ACT to fix the standard barrel for fruits, vegetables, and other dry commodities.** This act was approved March 4, 1915, and the rules and regulations are made by the Director of the Bureau of Standards and approved by the Secretary of Commerce. The dimensions are the same as those given in the preceding paragraph, and the thickness of staves must not be greater than four-tenths of an inch, but any barrel of a different form with a capacity of 7,056 cubic inches is also standard.

Barrels for shipment to foreign countries may be constructed according to the directions of the foreign customer, provided they conform to the laws of the country to which they are to be shipped.

THE UNITED STATES COTTON FUTURES ACT was approved in 1914, reenacted in 1916, and amended March 4, 1919. Its object is to tax the privilege of dealing on exchanges, boards of trade, and similar places in contracts of sale of cotton for future delivery. It provides that the Secretary of Agriculture shall establish and publish official standards of cotton, and that an excess of 2 cents per pound shall be levied on all cotton involved in any contract of sale for future delivery, unless the contract conforms to certain requirements, most of which involve the question of grades.

WAREHOUSE ACT. This was approved in 1916, its object being to afford proper storage, warehousing, classification according to grades and otherwise, weighing, and certification of agricultural products, namely, cotton, wool, grains, tobacco, and flaxseed, which it is desired to store for interstate or foreign commerce. The Secretary of Agriculture issues licenses to warehousemen or others under conditions required by the act, and exacts bonds for the faithful performance of obligations under the laws of the state, territory, or district in which the warehouse is conducted and as required by the act, and such obligations as are assumed in the contract with the depositor of agricultural products in the warehouse.

**AN ACT to fix standards for Climax baskets for grapes and other fruits and vegetables, and for baskets and other containers for small fruits, berries, and vegetables.** This act, approved Aug. 31, 1916, fixes the sizes and dimensions (in inches) of Climax baskets thus:

| | 2 qt. | 4qt. | 12 qt. |
|---|---|---|---|
| Length of bottom piece.... | $9\frac{1}{2}$ | 12 | 16 |
| Width " " " .... | $3\frac{1}{2}$ | $4\frac{1}{2}$ | $6\frac{1}{2}$ |
| Thickness of bottom piece.. | $\frac{3}{8}$ | $\frac{3}{8}$ | $\frac{7}{16}$ |
| Height (outside)............ | $3\frac{7}{8}$ | $4\frac{11}{16}$ | $7\frac{1}{16}$ |
| Top and cover: length........ | 11 | 14 | 19 |
| Top and cover: width......... | 5 | $6\frac{1}{4}$ | 9 |

The sizes of standard baskets or other containers for small fruits, berries, and vegetables are the dry half-pint, pint, and quart or a multiple of one of these, containing, respectively, 16 8/10, 33 6/10 inches, and 67 2/10 cubic inches.

Baskets or containers intended for export may conform to the specifications of the foreign purchaser, but must conform with the laws of the country to which shipped.

AN ACT to standardize lime barrels. This act, approved in 1916, and administered by the Bureau of Standards, establishes a large and small barrel of lime, the former consisting of 280 pounds and the latter of 180 pounds net weight. Containers of less capacity than the small barrel must be sold as fractional parts of such barrel.

THE GRAIN STANDARDS ACT. This act, approved Aug. 11, 1917, authorizes the Secretary to investigate the handling, grading, and transportation of grain, and to fix standards of quantity and condition for corn, wheat, rye, oats, barley, flaxseed, and such other grains as in his judgment may be permitted and warranted by the usages of the trade, these standards to be known as the official grain standards of the United States. He appoints grain inspectors, and grains for which standards are fixed, for either interstate or foreign commerce, must conform to the grades claimed.

PACKERS AND STOCKYARDS ACT approved Aug. 15, 1921, regulates interstate and foreign commerce in livestock and livestock products. It makes it unlawful for any packer to (1) use any unfair, injuriously discriminatory, or deceptive practice or device in commerce; (2) make or give in commerce any undue or unreasonable preference or advantage to any person or locality, or subject either to undue or unreasonable prejudice or disadvantage in any respect; (3) deal with or for any other packer in buying or selling for the purpose or with the effect of apportioning the supply in commerce so as to tend to restrain commerce or create a monopoly; (4) buy or sell for the purpose or with the effect of manipulating or controlling prices, creating a monopoly in any article, or restraining commerce; (5) engage in business or do any act for the purpose of manipulating or controlling prices, creating a monopoly, or restraining commerce; (6) enter into any arrangement with another to do anything made unlawful by the foregoing provisions.

A packer believed by the Secretary of Agriculture to have violated the law is served with a complaint and a hearing is arranged. If the evidence sustains the complaint, he is served with an order from the Secretary to desist, which is final, except that the packer may appeal to the court as prescribed by law.

It is the duty of every stockyard owner and agency to furnish, on reasonable request, without discrimination, reasonable stockyard service, at reasonable, just, and non-discriminatory charges. Thirty days after the Secretary

of Agriculture gives public notice that any stockyard as such within the meaning of the Act, no one may carry on a market agency or dealer business there unless he has registered according to regulations with the Secretary his name, address, character of his business, etc.

Within 60 days after the Secretary has acted as above, the stockyard owner and every market agency there must file with him and print and keep available to the public, schedules of rates and charges for stockyard services. A market agency beginning business at a stockyard after the 60-days notice of the Secretary must file schedules before furnishing any service. Changes may ordinarily be made only after ten-days' notice to the Secretary and the public.

When there is reasonable ground for complaint against any stockyard owner, market agency, or dealer, the Secretary shall make an investigation. If the findings are in favor of the complainant, the Secretary issues an order directing the defendant to pay the claimant, and in case of non-compliance the law may be evoked within one year.

Should the Secretary determine that any rate, charge, regulation, or practice of any stockyard owner or market agency is unjust, unreasonable, or discriminatory, he may order it stopped and may prescribe changes.

Whenever the Secretary upon investigation finds that any rate, charge, regulation, or practice of any stockyard owner or market agency causes any undue or unreasonable advantage, prejudice, or preference as between persons or localities in intrastate commerce on the one hand and interstate or foreign commerce on the other hand, he prescribes remedial changes.

It is unlawful for any stockyard owner, market agency, or dealer to engage in or use any unfair, injuriously discriminatory, or deceptive practice or device. On complaint or if convinced that these provisions are being violated the Secretary, after notice and hearing, may order that such violation shall cease.

Every packer, stockyard owner, and market agency is required to keep necessary records to show all his business transactions.

**AN ACT taxing grain futures contracts.** This act, approved Aug. 24, 1921, levies a tax of 20 per cent in addition to the taxes already imposed, on each bushel of wheat, corn, oats, barley, rye, flax, and sorghum, involved in any privilege or option for contract for purchase or sale of grain for future delivery, except (1) when the seller is at time of making the contract the owner of the commodity involved or grower thereof, or either party to the contract is owner or renter of land on which it is to be grown, or is an association of owners or growers of grain of such owners or renters of land; or (2) when the contract is made by or through a member of a board of trade designated by the Secretary of Agriculture as a "contract market." This may be a board of trade that has complied with certain conditions in the act.

The Secretary shall investigate and furnish information regarding marketing conditions of grain and grain products and by-products. He is authorized to investigate operations of boards of trade, and publish such results as he deems of interest, except such as would disclose any person's business transactions, trade secrets, or names of customers. He may publish reports regarding boards of trade or persons found guilty of violating the law.

## Laws Relating to Rural Construction

Probably no single factor connected with agricultural progress is more important than good roads. The public road or highway is of interest not only to the people living in the territory through which it passes, but also to the traveling public generally. The question of good roads is, therefore, largely a national question, which fact was recognized by the Federal Government in

**THE FEDERAL AID ROAD ACT.** This was approved in 1916, and amended and supplemented by an act approved Nov. 9, 1921. Its object is to aid the states in building toll-free rural post roads and in building and maintaining roads and trails in or near national forests necessary for the development of resources on which those living in or near these forests depend. For the roads first mentioned the act provided a total of $75,000,000 for use between 1917 and 1921, a certain sum being made available each year; and $75,000,000 for the year ending June 30, 1922. For forest roads and trails, $5,000,000 for the year ending June 30, 1922, and $10,000,000 for that ending June 30, 1923. The Secretary of Agriculture apportions the appropriation for post roads among the states on the bases of area, population, and mileage of rural delivery and star routes.

Each state designates a system of highways, (not to exceed 7 per cent of its total highway mileage on Nov. 9, 1921) upon which all Federal-aid apportionments are expended.

Two classes of highways may receive Federal aid: primary or interstate highways, which may not exceed 3/7 of the total mileage which may receive such aid; and secondary or intercounty highways. The Secretary in approving projects is required to give preference to the former. No project is approved until the state has made provision for its part of the required funds.

When a state wishes to avail itself of the act, its highway department prepares plans which must be approved by the Secretary of Agriculture before construction begins. The road must be built under the supervision of the highway department and maintained by the state or by a civil division of it, as its laws provide. Should any state fail to maintain a Federal-aid highway the Secretary, after due notice, has it put in condition, charges the cost against the Federal funds allotted to the State and refuses to approve other projects of such state until it reimburses the Government.

## Financial Legislation for the Farmer

Compared with other classes, the farmer was, until recently, at a distinct disadvantage with respect to his ability to borrow funds with which to finance his operations. This was because farm lands were not regarded by the financial world as bankable assets and because a farmer rarely had collateral security to offer. As a result of the study and efforts made by Congress and many able financiers—which included investigations by a special commission that visited Europe—we have the

**FEDERAL FARM LOAN ACT.** This was approved July 17, 1916, and amended as of April 20, 1920, May 29, 1920, March 4, 1921, and July 1, 1921. It administered by the Treasury Department through a Federal Farm Loan Board created by the act and consisting of the Secretary of the Treasury and 4 citizens of the United States, not more than 2 of whom may be of the same political party, who are appointed by the President.

**The work of the Board.** It is the duty of the Board to divide continental United States (exclusive of Alaska) into 12 Federal Bank Districts; to establish a Federal land bank in each district and designate the city in which its principal office shall be located; to appoint a farm-loan registrar, one or more land-bank appraisers, and as many land-bank examiners as may be deemed necessary for each, and may appoint a deputy registrar; from time to time to require examinations and reports of conditions of all land banks and publish consolidated statements of results; to have appraisals made of farm lands as provided for in the act; to prepare and publish amortization tables; and to publish and distribute bulletins setting forth the principal features of the act and circulars instructing farmers regarding methods and principles of coöperative credit and organiation in connection with it.

**Federal Land Banks.** Each Federal Land Bank is temporarily managed by 5 directors appointed by the board, who choose from their number a president, vice president, secretary, and treasurer, and employ necessary assistants. It is the duty of the directors to make an organization certificate, which must show name of the bank, the district in which it is to operate, the city in which the principal office is to be located, the amount of capital stock and number of shares into which this is divided, and the fact that the certificate is made to enable the farmers to avail themselves of the advantages of the act. When this certificate is duly acknowledged, authenticated, and transmitted to the Farm Loan Commissioner, the bank becomes a corporate body with powers as defined by the act.

The stock of each bank is divided into shares of $5 each, and may be held by any individual, combination of individuals, or the Government. It is the duty of the Government to subscribe the balance of the stock of any such bank which remains unsubscribed 30 days after its subscription books have been opened. Before beginning business, a Federal land bank must have a subscribed capital stock of not less than $750,000.

On request of the Federal Farm Loan Board, the Secretary of the Treasury may deposit unappropriated funds in any Federal Land Bank for its temporary use, but these aggregate deposits may not exceed $6,000,000 at any one time. Until the aggregate paid-in capital stock of the twelve land banks is $50,000,000 or more, the Secretary of the Treasury may make additional deposits. These are to be secured, redeemed, and paid as above provided except that they must be called by the Secretary of the Treasury and redeemed by the bank or banks holding same within fifteen days after conclusion of each general offering of farm loan bonds by such bank or banks. The aggregate of such additional depositis outstanding at any time may not exceed the difference between the aggregate paid-in capital stock of the twelve land banks on the last day of the preceding month and $50,000,000. The certificate of indebtedness issued by the land bank for these additional deposits bears a rate of interest not exceeding by more than one-half of one per cent per annum the rate borne by the last bond issue of the land bank receiving them.

**National Farm Loan Associations.** Whenever 10 or more persons who are owners, or about to become owners, of farm land qualified as security for a mortgage loan, desire to borrow money on farm-mortgage security,

they may organize one of these associations. Their articles of association must specify the object of the association and the territory in which it is to operate, must provide for an increase of capital stock, and must be signed by the persons uniting to form the association.

The articles of association forwarded to the Federal land bank of the district must be accompanied by a written report of the loan committee provided for in the act, and an affidavit signed by the secretary-treasurer, stating (1) that each of the subscribers is the owner, or about to become the owner, of farm land qualified as the basis of a mortgage loan; (2) that the loan desired by each is not more than $10,000 nor less than $100 and the aggregate not less than $20,000; (3) that the affidavit is accompanied by a subscription to stock of the Federal land bank equal to 5 per cent of the aggregate sum desired on mortgage loans; and (4) that a temporary organization has been formed as required by the act. On receipt of this the directors of the Federal land bank send an appraiser to investigate the character and solvency of the applicants and the value of their lands, determine whether a charter should be granted, and forward the articles of association, with the appraiser's recommendations, to the Federal Farm Loan Board. If the recommendations are favorable, this Board grants the charter and designates the territory in which the association may make loans.

Whenever an association desires to secure a loan on first mortgage for any of its members, it subscribes for the capital stock of the Federal land bank of its district to the amount of 5 per cent of such loan. This subscription is paid in cash when the loan is granted and the capital stock is held by the Federal land bank as collateral security for the payment of the loan. The par value of each share in a farm loan association is $5, and the shareholders are entitled to one vote on each share, up to 20, at all elections of directors and at meetings of the shareholders.

After the farm loan associations have subscribed for not less than $100,000 of the capital stock of the Federal land bank of their district, the permanent officers and board of directors of the bank are chosen. The board consists of 6 local directors, who are elected by the National Farm Loan Associations, and 3 district directors, who are appointed by the Federal Farm Loan Board. All directors must have resided in their respective districts not less than 2 years, and at least one of the district directors must be an experienced farmer and engaged in actual farming in his district at the time of appointment.

**Association membership.** After a charter has been granted to a farm loan association, any person who is an owner, or about to become an owner, of qualified farm land and who desires to borrow on a mortgage on such land may become a member of the association upon a two-thirds vote of the directors, and by subscribing for the capital stock of the association at the rate of one share for each $100 of the face value of the loan desired, his subscription to be paid in cash when the loan is granted. This capital stock is held by the association as collateral security for the payment of the loan, the borrower is paid any dividends accruing and payable on the stock while it is outstanding, and the stock is retired on full payment of the loan.

Every shareholder in a farm loan association is individually responsible for all obligations of the association to the amount of his stock at par, in addition to the amount paid in and represented by his shares.

**How to borrow money.** Whenever a member of a farm loan association applies for a mortgage loan, its loan committee investigates the character and solvency of the applicant and the security offered and makes a written report, which must be unanimously approved before a loan is made. This report and the application are referred to the Federal land bank, examined by its directors, and then referred to one or more of the land-bank appraisers, who also investigate; if the report is approved the loan is made.

Each farm loan association has power to indorse mortgages taken from its shareholders by the Federal land bank of its district; to acquire and dispose of such real or personal property as may be necessary or convenient in its business; to fix reasonable initial charges for loans, not to exceed amounts fixed by the Board and in no case to exceed 1 per cent of amount of loan for which application is made; and to issue certificates against deposits of current funds bearing interest for not over 1 year at not to exceed 4 per cent per annum after 6 days from date, convertible into farm loan bonds when presented at the Federal land bank in the amount of $25 or any multiple thereof. Such deposits when received are transmitted to the land bank and invested by it in farm loan bonds issued by a Federal land bank or in first mortgages.

Every such mortgage contains an agreement providing for repayment of the loan on an amortization plan, the debt to be extinguished in not less than 5 nor more than 40 years. Before the first issue of farm-loan bonds by any land bank, the interest rate on mortgages may be determined in the discretion of said bank, subject to the limitations and provisions of the act.

Any joint-stock land bank may go into voluntary liquidation by making provision for payment of its liabilities, with the approval of the Federal Farm Loan Board, and if the method of liquidation has been duly authorized by a vote of at least two-thirds of the shareholders. To assist in such liquidation, any Federal bank may, with the approval of

the Farm Loan Board acquire the assets and assume the liabilities of any joint stock land bank, waiving the provisions requiring it to acquire its loans only through national farm loan associations or agents and the provisions relating to status of borrowers, purposes of loan, and limitation as to amount of individual loans. No Federal bank may assume obligations of any joint-stock land bank exceeding twenty times its capital stock, except by the creation of a special reserve equal to one-twentieth of the amount of the additional obligations.

Whenever a farm loan association is voluntarily liquidated, a sum equal to its reserve becomes the property of the Federal land bank in which it is a shareholder.

**Purposes for which money may be borrowed.** Loans by Federal land banks are restricted to first mortgages on farm lands within the respective Federal land-bank district and loans may be made only for the purchase of lands for agricultural purposes, for necessary equipment, fertilizers, and livestock; to provide buildings; for the improvement of farm lands; and to cover indebtedness existing at the time of the organization of the first national farm loan association established in or for the county in which the mortgaged land is located; or indebtedness incurred for the purposes mentioned.

**Joint stock banks.** Not less than 10 persons may also form what is known as a joint stock land bank for lending on farm mortgage securities and issuing farm loan bonds, the organization to be subject to the requirements, and under the conditions, so far as applicable, prescribed for Federal land banks. The board of directors of each of these banks is composed of not less than 5 members, and, as in the farm loan associations, each shareholder is responsible for the bank's obligations to the extent of the amount of his stock at par value, as well as the amount paid in and represented by his stock, and each has the same voting privilege as the holder of shares in a national banking association. The Government may not purchase or subscribe for the capital stock of these banks.

A joint land bank may lend money on first mortgages on farm lands within the state in which its principal office is located or in a contiguous state, subject to all other restrictions on Federal land bank loans. Each joint-stock bank has authority to issue bonds based on mortgages taken by it, and the rate of interest which it may charge on farm loans may not exceed by more than 1 per cent the rate established for the last series of farm loan bonds which it issued.

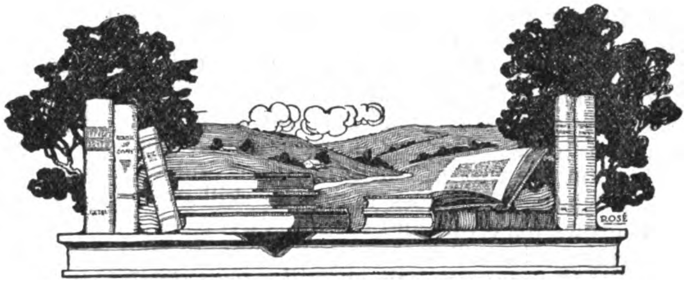
**Farm loan bonds** are issued by the Federal Farm Loan Board to any Federal land bank or joint stock land bank which has voted to issue farm loan bonds when such bank makes written application through the farm loan registrar of the district, accompanied by satisfactory collateral security, consisting of first mortgages on qualified farm lands or U. S. Government bonds aggregating not less than the amount of the bonds to be issued, and such information as the Board requires.

These farm loan bonds are issued in denominations of $40, $100, $500, and $1,000, and such larger denominations as the Board may authorize, and in series of not less than $50,000, the amount and terms being fixed by the Federal Farm Loan Board. They run for specified minimum and maximum periods, and are subject to payment and retirement at the option of the land bank any time after expiration of the minimum period, which shall not be longer than 10 years from the date of issue. The original interest rate was 5½ per cent per annum, but no bonds issued or sold after June 30, 1923, may bear more than 5 per cent interest per annum.

Every Federal farm land bank issuing farm loan bonds is primarily liable for them and for interest payments due upon any farm loan bonds issued by other Federal land banks remaining unpaid in consequence of the default of such banks, and also for such portion of the principal of farm loan bonds as have not been paid after the assets of any such other land bank have been liquidated and distributed; but such losses must be assessed by the Federal Farm Loan Board against liable solvent banks in proportion to the amount of their outstanding farm loan bonds.

**Reserves and dividends.** Each Federal land bank and joint stock land bank must carry 25 per cent, and each farm loan association 10 per cent, of its net earnings semi-annually to its reserve account until same shows a balance equal to 20 per cent of its outstanding capital stock; thereafter each Federal land bank and joint stock land bank must carry 5 per cent, and each farm loan association 2 per cent, annually to its reserve. After deducting this, a dividend of the whole or any part of the balance of the net earnings may be declared.

**Taxation.** Every Federal land bank and every national farm loan association, including capital and reserve or surplus and income derived from same, is exempt from Federal, state, municipal, and local taxation, except taxes on real estate held, purchased, or taken under the provisions of the act, first mortgages executed to Federal land banks, and farm land banks, and farm loan bonds issued by these banks under the provisions of the act, and income derived therefrom.



## CHAPTER 8

# Rural Economics

*By* THOMAS NIXON CARVER, *Professor of Economics in Harvard University, who has made a special study of this broad, complex, and difficult but highly important subject, both as a student and as a dweller and worker in the open country. In addition to teaching it at Oberlin College between 1894 and 1900, and at Harvard since 1900, he was Director of the Rural Organization Service of the U. S. Department of Agriculture in 1913-1914, and special adviser in agricultural economics to the Department in 1914-1915. He was born on an Iowa farm; filed a homestead claim in California, and ran a dairy while attending the University of Southern California; and has traveled and studied rural conditions in Germany, France, Italy, Switzerland, Belgium and Holland in addition to many sections of this country. Because of their unfamiliarity with this abstract subject, many persons prefer to "side-step" it, to close their eyes to its existence, rather than to make an effort to understand its principles and applications. In the past such an attitude was perhaps a safe one. In modern times the importance of farming as a business in its relation to national affairs, and the importance of the farm population in its relation to national life make some knowledge of economics an essential part of a well-rounded education. It is, moreover, part of the working equipment of the successful up-to-date farmer; for, after all, rural economics is simply another name for "Big Business in the Farm Community"—and what is closer than that to the farmer's interests?*—EDITOR.

RURAL economics may, perhaps, be best described as the science that investigates the conditions and laws affecting production, distribution, and consumption in the agricultural industry. It deals with such questions as the relation of agriculture to the life and labor of the nation as a whole, the systems of agriculture which contribute most to the prosperity of the whole agricultural class (including those who contribute only their labor as well as those who contribute their land), the systems of land tenure which give greatest stability and prosperity to the rural population, the systems of farm finance which promote the flow of capital into the most productive channels, the methods of marketing agricultural produce, and the best methods of organizing rural communities for the improvement of general social and living conditions in the open country.

The prosperity of agriculture is, as we are coming to see, greatly influenced by its contact with other lines of business and the lives of the nonagricultural classes, as well as by the policies of the Federal, state, and local governments. The rural economist should make a careful and comprehensive study of all these topics, and possess himself of some expert knowledge regarding some or all of them.

There was a stage in agricultural development when each farm was almost

sufficient unto itself, practically everything grown on the farm being consumed by the farmer's own household, and practically everything consumed being grown on the farm. The farmer was neither a buyer nor a seller on a large scale. The welfare of the household depended almost exclusively on the quality of the land and the internal efficiency of the farm organization. We have passed beyond that stage, and it is safe to say that the prosperity of the average farmer of to-day depends quite as much upon his contact with the outside world, upon the way in which his labor and enterprise fit into that of the nation as a whole, as it does upon the skill or industry with which the farmer himself grows his crops and feeds his livestock. He has become a buyer of raw materials and a seller of finished products, and is, therefore, in a very real sense a manufacturer, though he still works mainly out of doors rather than indoors. He is a capitalist and a user of capital, but he can scarcely expect to succeed in a large way without a knowledge of the nature of capital and its possibilities. More farmers fail because they are poor buyers and sellers, poor investors, and poor financiers than because they are poor producers.

## Economic Characteristics of Agriculture

There are two outstanding facts which give character to agriculture and which distinguish it fundamentally from all other industries. The first is its greater dependence upon space; the other is its seasonal character. By its greater dependence upon space, is meant that, in proportion to the value of the product, more space is required in agriculture than in either manufacturing or mining. Forestry and fish culture, also, require wide spaces, but it is a question if they be not forms of agriculture. Certainly they are rural, rather than urban, in their character. By the seasonal character of agriculture is meant the fact that agricultural work changes with the seasons of the year and even with the hours of the day, so that no one is compelled to work at one and the same task year in and year out.

**Agriculture is dependent upon wide spaces.** Because of its demands upon space, agriculture must continue to be an outdoor industry. There is no reason why crops should not be grown indoors under glass except that so much space is required as to make the cost of housing prohibitive. In a few cases, indeed, where crops of high commercial value can be grown in small space, they are grown economically indoors, but such crops furnish a negligible fraction of the world's supply of food and clothing. Agricultural enterprise is, therefore, and, so far as we can see, must continue to be, "rural," that is, pertaining to the fields and open spaces.

So fundamental is ample space to agricultural development that it has given character to the historical development of rural people. The increase of numbers among the people of rural districts has always necessitated an extension of their agricultural area. Accordingly, rural migrations have always been in search of more space and wider fields as well as newer soil. We must distinguish, however, a strictly rural migration from a movement from country to city. By a rural migration is meant a migration of rural people who expect to continue in rural work. The movement of such people, in the absence of geologic or climatic changes, has always been away from densely populated toward sparsely inhabited regions.

Before the rise of the present commercial and manufacturing era, international wars were generally concerned, either directly or indirectly, with problems of territorial expansion. In an agricultural age a great nation can be built only on wide territories. Manufacturing and commerce, however, depend primarily upon markets and only secondarily upon territorial expansion. Given ample markets, that is, an ample source of raw material and ample opportunities for selling finished products, there is scarcely any conceivable limit to the density of urban population. As soon as markets are limited, urban populations are limited. The rivalry, therefore, of commercial and manufacturing nations is mainly concerned with markets. A great manufacturing and commercial nation can be built only on wide markets. Since the beginning of the present manufacturing and commercial era, statesmen have concerned themselves more with questions of interna-

tional trade and markets and spheres of influence than with territorial expansion. In agricultural nations, however, the problems of statesmanship and diplomacy have had more to do with territorial expansion than with markets.

**Seasonal character of agriculture.** The seasonal character of agriculture is more pronounced in temperate than in tropical regions, for the simple reason that the seasons themselves are more variable in the former. The fact that agriculture is a matter of times and seasons, gives great diversity and variety to rural work, and prevents that extreme degree of specialization which is one of the outstanding characteristics of the indoor industries. The specialized farm is the exception rather than the rule. Comparatively few farms are profitable unless various products are grown; but even on the so-called specialized farm, the character of the work changes from season to season from day to day, and even from hour to hour. The morning, the evening, and the middle of the day, each has its special task; the spring, the summer, the autumn, and the winter, likewise, bring their special demands and changes of occupation.

Its dependence upon space tends to make agriculture necessarily a business of small units, at least as compared with the indoor industries. The difficulties of superintendence are so great that it would be almost impossible to administer a farm employing 1,000 men, to say nothing of 10,000; yet indoor industries, where men are working close together, can be successfully administered where even larger numbers of men are employed.

An even greater difficulty in administration is created by the seasonal character of agriculture. Not only must each man be assigned to a new task at different hours of the day and different seasons of the year in regular order, but unexpected changes of weather occasion unexpected and almost instantaneous changes in the nature, importance and arrangement of the operations that make up the work of the farm. To direct even 100 men efficiently where these changes are continually occurring, would test the executive capacity, initiative, and resourcefulness of even the greatest administrator. Various mechanical aids in administration, automatic check devices, etc., may be used in indoor industries to lighten the burdens of the administrator, but these are impossible in agriculture. It is, therefore, pretty certain, that even though moderately large-scale farming might, under certain circumstances, succeed, it would still be an industry of small units as compared with manufacturing, mining, or transportation.

## What is Good Agriculture?

What is good agriculture, from the standpoint of national prosperity? It is very easy to form a superficial opinion with regard to this question. A great deal has been written in recent years regarding the unscientific character of American agriculture as compared with that of older and more densely populated countries. Statistics of the yields per acre of the different countries are quoted, to the disadvantage of American agriculture, and, commonly, to the disadvantage of every other new and sparsely populated country.

But, before assuming that agriculture in all new and sparsely populated countries is as unscientific as is affirmed, we should ask ourselves whether production per acre is the only or the best test. If, instead of taking the product per acre, we should take the product per man, we should find that the new and more sparsely populated countries would head the list.

**Product per man versus product per acre.** There are many reasons for thinking that the product per man or per unit of labor is a better test of good or scientific agriculture than the product per acre. The yield per acre may depend upon a variety of physical and climatic circumstances, and may really have very little connection with the efficiency with which labor is applied. The product per unit of labor has a much closer connection with the efficiency of labor. Moreover, the standard of living and the general well-being of the agricultural class are determined more directly by the product per man or per family than by the product per acre.

There are some circumstances under which the product per man and product per acre are interdependent, where, in fact, they are inseparable. If we assume a fixed farm population and a fixed acreage of farm land, that is, a given number of people making a living off a given number of acres, then it must follow that the product per man can be increased only by increasing the product per acre, and the product per acre can be increased only by increasing the product per man. With a given population and a variable acreage, the product per man may be improved in some cases by increasing the acreage under cultivation, in other cases by decreasing it; that is, the agricultural population may spread over a wider area, or it may

abandon some of the land already under cultivation, if by doing either the one or the other it can increase the product per man. This would result, of course, in a larger acreage and more extensive cultivation in the one case, and a smaller acreage and more intensive cultivation in the other. Having the opportunity to cultivate as much or as little land as is found advantageous, the wisest policy would be for the population to spread over as much land as would enable it to produce the maximum per man.

The maximum product per man is generally found under conditions of somewhat extensive cultivation, that is, where the labor spreads itself over considerable land; but the inevitable result of this is that each acre of land receives comparatively little labor, or a small fraction of the labor of one man, as compared with what it would receive under intensive cultivation. This generally results in a somewhat small product per acre. Thus it frequently happens that a small product per acre and a large product per man are found in the same system of cultivation. If, for example, one farmer cultivates with his own labor 160 acres of land while another cultivates only 40, the 160-acre farmer may produce twice as much as the 40-acre farmer, even though he only gets one half as much per acre.

On the other hand, with a fixed acreage of agricultural land, but with a variable population, the product per man may be decreased or increased by increasing or decreasing the number of workers on the land. Under these circumstances, it is a good agricultural policy to put as many workers on the land as will enable them to produce the maximum per man.

**Landowning and farming classes.** The contrast between the results of intensive and of extensive cultivation indicates a rather clear and sharp conflict of interests between different portions of the agricultural population—between a landowning class, on the one hand, and a farming or laboring class, on the other. This conflict of interests creates a problem which can only be satisfactorily solved by the most careful consideration of the interests of both parties. It will certainly not be solved satisfactorily if the rural economist or the agricultural statesman listens to the arguments of one side alone. In those fortunate circumstances where the laboring class and the landowning class are one and the same, the problem is eliminated because the conflict is eliminated. That is, where every farm-owner operates his own farm and every farm-worker owns the land on which he works, there can obviously be no conflict of interests between a landowning and a land-working class; but, where one group owns the land and does not work upon it, and another group works upon the land which it does not own, a very definite conflict of interests arises. They who own the land are naturally anxious to increase the product per acre, if it can be done without too heavy an addition to the wage bill.

**Cheap labor means poverty.** A large supply of cheap labor makes possibe intensive cultivation where it would be economically impossible, were labor scarce and dear. In the former case, the owner can hire larger numbers of men to work his land, and can, therefore, cultivate it more thoroughly and get a larger product per acre and also a larger rent or income from the use of his land. But, from the standpoint of the workers, a large supply of cheap labor is decidedly undesirable. Cheap labor means poverty. When labor is scarce and dear, the workers are not in a condition of poverty. It is noteworthy that the countries which show a large product per acre are likewise the countries where labor is abundant and cheap, whereas the United States, Canada, Australia, and other civilized countries which show a small product per acre are the countries where labor is scarce and dear. The same thing may be stated in another way. The countries to which some of our popular writers and lecturers point as models of scientific agriculture because they show such large products per acre, are the countries in which the agricultural workers are in a condition of extreme poverty, whereas the countries to which they point as examples of unscientific or inefficient agriculture are the countries in which there is little or no poverty but a good deal of prosperity among the agricultural workers. We should hesitate, therefore, before we use the term "scientific" to describe a system of agriculture which is generally accompanied by the poverty of the workers on the land, even though it be accompanied by prosperity on the part of the owners of the land. It is almost a rule, although there are a few exceptions, that intensive cultivation and poverty go together, whereas extensive cultivation and prosperity are generally found associated.

## The Law of Diminishing Return

The reasons which lie behind this fact are not far to seek. The chief reason is found in the great law of agricultural production known as the law of diminishing return from land. Stated roughly, this law is that in the cultivation of any given crop, such as corn, wheat, potatoes, or any other that might be named, you cannot increase the yield per acre in exact proportion as you in-

**crease the labor used in cultivation. That is to say, you cannot double, treble, or quadruple the yield per acre by merely doubling, trebling, or quadrupling the labor used in its cultivation. If, for example, it should be found to be true that 1 man with 1 team could produce 40 bushels of corn to the acre on a given field, it might possibly be true, also, that 2 men with 2 teams, devoting their entire time to the same field, could double the yield and bring it up to 80 bushels per acre, though this is very doubtful. Three men with 3 teams, devoting their entire time to the same field, would certainly not triple the yield. Much less would 4 men with 4 teams quadruple the yield. But, unless the yield was actually doubled, tripled, or quadrupled as the labor force was thus increased, the necessary and mathematical result would be that the yield per man and team would be reduced. If, for example, 1 man with 1 team could produce 40 bushels, and 2 men with 2 teams could produce 70 bushels, the yield per man in the first case would obviously be 40 bushels multiplied by the number of acres, whereas in the second case the yield would only be 35 bushels multiplied by the number of acres. Again, if 3 men with 3 teams could force a yield of 90 bushels to the acre, the yield per man would be still further reduced to 30 bushels multiplied by the number of acres. And if 4 men with 4 teams could manage to secure a yield of 100 bushels to the acre, the yield per man would be only 25 bushels multiplied by the number of acres. The yield per man would, therefore, under the conditions which we have assumed, decline from 40 bushels to 25 bushels, multiplied by the given number of acres, as the number of cultivators was increased from 1 to 4.**

The "marginal product." The average yield, however, is not the most important consideration. Economists are in the habit of using a somewhat technical term to describe the advantage of adding an extra man to the force already at work in the cultivation of a given field or farm. This technical term is known as the "marginal product." For this there is, unfortunately, no popular equivalent; it must, therefore, be explained at some length in nontechnical language.

One problem which the farmer who employs labor in the cultivation of his farm must consider,

is the addition to his total crop which should result from the addition of 1 man or 1 unit of

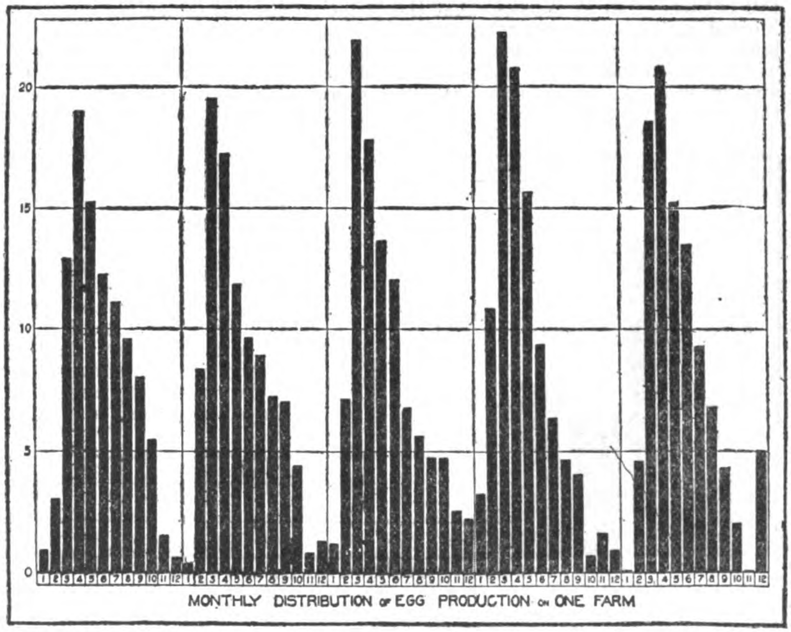



FIG. 75. There are some difficult features of the farming business that even the highest human efficiency cannot improve; the irregular distribution of its output is one of them. This chart shows the relative egg production by months for five years on one farm. (Wis. Bulletin 209.)

labor to his total force. Practically the same problem is involved in calculating how much the total product would be reduced by taking away one unit from his total labor force. It is at this point that he must consider carefully the problem of profits and losses. If by adding a unit of labor to his existing forces at a cost, say, of $100, he may reasonably expect to add more than $100 to the value of his product, it will be good business to hire the extra unit of labor. If, however, whatever the average product of all the units of labor may be, the addition of another unit to the total force will not add $100 to the total product, it will be poor business to employ it.

This may be reduced to arithmetical terms by assuming that in the figures given above we are considering a 20-acre field, upon which 1 man and 1 team can grow 40 bushels to the acre, or a total product of 20 times 40, or 800 bushels. However, if 2 men with 2 teams, under the above assumption, produce 70 bushels to the acre, the total product is 20 times 70, or 1,400 bushels. In this case, the average product is 20 times 35, or 700 bushels. But the additional product created by the second man and team is only 600 bushels; that is, the difference between 800, the product of 1 man and 1 team, and 1,400, the product of 2 men and 2 teams. The farmer who employs this second man will lose money on him, if he pays him more than the value of 600 bushels. Let us suppose that the farmer himself is the first man who works on the land. If he works it entirely by himself, he will have a total of 800 bushels; if he hires another man and team, and pays them more than for 600 bushels, he will have less for himself than he would have had if he had cultivated it alone.

Let us carry the analysis a step further, and assume that by hiring a third man with a team the farmer could get 90 bushels to the acre, or a total of 20 times 90, or 1,800 bushels. In this case, the average for the 3 men and 3 teams would be 600 bushels, but the third man would add only the difference between 1,400 and 1,800 bushels, namely, 400 bushels. It would pay the farmer better to get along with 2 men and 2 teams than to hire the third man and team, unless he could get this third man and team for the value of 400 bushels or less.

Finally, on the extreme assumption that 4 men with 4 teams could force a yield of 100 bushels to the acre, or a total of 20 times 100, or 2,000 bushels, while the average product of 4 men and 4 teams would be 500 bushels, the additional product resulting from the addition of the fourth man to the other 3 would be only the difference between 1,800, the production of 3 men and 3 teams, and 2,000, the production of 4 men and 4 teams. This would be only 200 bushels. It would obviously be unprofitable for the farmer to hire this fourth man, unless he could get him for the value of 200 bushels or less.

This additional product which results from the additional unit of labor is always less than the average product, and this additional product, rather than the average product, is the one which determines whether the farmer can afford to add to his labor force or not. If the labor of men and teams should be very cheap, our farmer could well afford to apply the labor of 4 men and teams to his field; if dear, he obviously could not afford to employ so many. This law of diminishing return, together with the fact that the marginal product is always less than the average product, is the underlying reason why land is generally cultivated intensively where labor is cheap, and extensively where labor is dear.

As the price of farm labor goes down, assuming that its efficiency is not correspondingly decreased, the advantages of owning land increase. Land tends to grow dear as farm labor grows cheap; but where labor is very scarce and dear, the rents or the profit of landownership are at the same time low. In other words, as farm labor grows dear, land grows cheap. If it happens that the average farmer is not a land-working and landowning farmer, but one class owns the land and another class does the labor, the conflict of in-

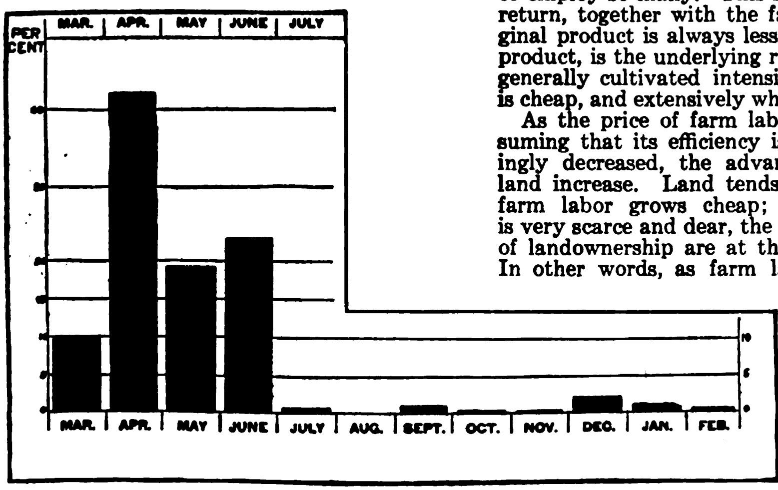



FIG. 76. As a result of irregular production, commercial practices based on farming activities also lack seasonal uniformity. This shows the relative quantities of eggs put into cold storage each month by a Chicago firm. (Wis. Bulletin 209.)

terests, referred to above, begins to grow acute. The working class will have an equally strong interest in reducing the supply and raising the price of labor.

**Farmers should economize on scarcest factor.** From the standpoint of the individual farmer who does not exercise control over the general conditions of agriculture, but has to accept them much as he finds them, it is always important that he should economize on the factor which happens to be most scarce. Where labor is scarce and dear, it is very important that each laborer be equipped not only with good and an ample supply of tools, but with plenty of land. It would be very poor economy to give a high-priced man a very inferior team and set of tools with which to work. It is equally uneconomical to give him a small quantity of poor land. New countries, where population is still sparse and labor, consequently, scarce and dear, are the countries in which agricultural science develops in the direction of labor-saving devices rather than of land-saving ones. Farmers, however, in countries in which land is scarce and dear, while labor is abundant and cheap, have a different problem to face. They must manage to get a large product from their expensive land. It would be very poor economy to apply to an acre of very expensive land a very small fraction of the labor of a man. In short, agricultural science in such a country naturally develops in the direction of land-saving devices. In a sparsely populated country, where land is cheap and labor dear, the scientific problem is how to get the maximum from the expensive factor, namely, labor. In densely populated countries, where land is dear and labor cheap, the scientific problem is, on the contrary, how to get the maximum product from the expensive factor, land. It is, therefore, no accident that agricultural machinery and labor-saving devices develop first in new and sparsely populated countries and are very slowly introduced in older and densely populated countries. Nor, at the same time, is it a mere accident that chemical fertilizers, deep tillage, scientific drainage, etc., reach their highest development in the old and densely populated countries.

**Intensive cultivation, when to be encouraged.** In times of national crises, when there is a dangerous scarcity of food supply, it may at first sight seem desirable that intensive cultivation be encouraged, in order that a larger food supply may be acquired. Intensive cultivation is to be encouraged whenever it can be carried on without reducing the product per man among the workers. This may be done by giving each man better tools and equipment and the use of more fertilizer; by the substitution, let us say, of larger for smaller teams, of horsepower for ox-power, of engine power for horsepower, we may enable a given number of men to cultivate a given area of land more intensively than would be possible without this change to a superior kind of power. By this means we may get not only a larger product per acre, but also a larger product per man. But, if instead of encouraging this method, our agricultural statesmen should encourage the mere massing of more labor upon the land, thus reducing the product per man, it will fail to add to the available food supply. For example, it is not the total product of the farm which will contribute to the feeding of the rest of the country, either in time of war or of peace. It is the surplus sold off the farm. If many laborers are massed on each farm, with a consequent reduction in the product per man, it may also result in a reduction in the surplus to be sold from each farm, more being required to feed and clothe the people on the farms. Thus the very purpose of increasing the nation's available food supply would be defeated.

In time of war, when a vast surplus of food is required not only for the armies, but for the munition workers and others who are taken out of the ordinary lines of productive industry, it is the quantity of this surplus which can be spared from the feeding of the farm population which is of extreme importance. This surplus is not likely to be increased by merely massing increasing numbers of men on the farms. The only scientific or successful way to increase this surplus is to cultivate more land or to give to each farm worker, as suggested above, a better equipment in the way of tools, fertilizer, and other aids to agricultural production.

It is a noteworthy fact that the very countries which have been held up as models of efficient agriculture because of their large product per acre, are those which have little to spare in the way of surplus food, owing to the large number of people on the farms who have to be fed, and the small product per man. On the other hand, the countries where extensive agriculture is carried on, are the only ones whose farms provide large food surpluses for the nonagricultural populations. There are relatively few people on these farms to be fed and clothed, and, at the same time, the product per man is relatively high; this necessarily leaves a large surplus which is available for feeding the armies, munition workers, and other nonagricultural people.

## Land Tenure

From what was said above regarding the conflict of interests wherever the landowning class and the farming class are separated, it must have appeared

already that the problem of land tenure and of the relation of the workers to the land is a problem of first importance. There are 3 recognized systems in operation on a large scale in the chief agricultural countries of the world, each system having its merits and its demerits. In the first place there is the system with which we in the United States are most familiar, under which the farm-owner and the farm-worker are one and the same man. This is by no means universal, even in this country, but it may be said to be the typical or characteristic American system. It exists in some parts of Europe also, and is there called the peasant-proprietor system. Another system, quite familiar in this country, though not so distinctively characteristic as the farmer-owner system, is the landlord-and-tenant system; that is, the system under which one man owns the land, receiving rent for it, and another man assumes the business management, sometimes doing his own work, sometimes hiring his labor. In the latter case, the farmer is sometimes a large business man, hiring or renting the land on which he works, just as many a business man does in the city, and also depending mainly upon hired help as the typical business man does. The farmer in this case merely performs the dual functions of general business manager and capitalist. In other cases, however, the tenant hires practically no help, but does all the work on his rented farm with his own labor and that of his family. There is every gradation between these two extremes.

The third system is what we may call the managerial system, where the landowner does not rent his farm, but actually runs it as a business man. He may hire a manager or do his own work of management. In either case, he supplies not only the land, but the equipment, also, assumes the risks and responsibilities, and exercises at least some general supervision. The functions of landowner and business manager are combined in the same person.

**The farmer-owner.** From the standpoint of production, no system has ever proved so effective as the first-named, where the farmer owns his land, his equipment, and his livestock. The general experience of the world shows that he cannot be beaten in the field of production. He is at a distinct disadvantage, however, in certain phases of the commercial side of his business. He is not favorably situated as a buyer and seller. He who can buy and sell on a large scale has an advantage in bargaining over him who can buy and sell on a small scale only. It is very important that we should distinguish between efficiency in production and efficiency in buying and selling. The individual who buys on a large scale can generally attract the notice and secure the favorable attention of the people who have goods to sell. His custom is so desirable that dealers will give him special terms. On the other hand, the individual who buys only small quantities has much more difficulty in getting favorable terms and special quotations.

The problem of buying and selling is one of increasing importance in agriculture. In spite of his effectiveness as a producer, the small farmer who does his own work may find himself severely handicapped because of his inefficiency as a buyer and seller. Apparently his only remedy lies in organization and coöperation. This does not mean coöperative farming in the sense of coöperative production or coöperative work in the actual growing of crops and raising of livestock. It literally means coöperation in buying and selling, though occasionally some manufacturing may have to be done as an aid to the selling of farm produce. Coöperative farming or farm production has not succeeded on a large scale anywhere, but coöperative buying and selling has proved very successful wherever it has been given a fair trial. It gives the small farmer the same advantage in buying and selling which would otherwise be the exclusive possession of the large farmer. If the small farmer can secure this advantage, it is safe to say that he can never be driven out by the competition of the large farmer, for the reason that, as a producer, he is quite as efficient as, if not more efficient than, the large farmer, at least on the average and in the long run.

**Landlord-and-tenant system.** The system of landlord and tenant has some advantages, provided the landlord assumes a real function in the farming business. A large farm-owner who selects his tenants carefully, exercises some supervision, and devotes time and energy and brings his superior intellect to the study of the larger and more scientific aspects of farming, may be of great help to his

tenants; and it is not impossible that a tenant might prosper more under such a landlord than as an independent owner. That is, the disadvantage of having to pay rent might be more than compensated by the advantage of having a highly trained scientific expert and public-spirited man as an adviser. The landowner, not having to give much attention to the details of running the farm, may become a specialist in some of the larger aspects of agriculture; at the same time, the tenant, being relieved of this kind of work, may devote himself exclusively to the detailed management of the farm. Thus, both he and the landowner become specialists and experts. Again, the landowner may become a natural leader in agricultural enterprises, such as coöperative buying and selling, whereas in many a community of landowning farmers no natural leader is found and coöperative organization is, therefore, difficult to carry on.

**Absentee landlordism.** We have presented the landlord-and-tenant system in its most favorable form. At the other extreme we have what is known as absentee landlordism. Under this system the landlord not only lives entirely apart from his land, and therefore takes very little interest in it except to collect his rents, but he performs no useful function whatsoever in agricultural development. Since he lives somewhere else, and spends his income somewhere else, the land is drained of its surplus income, and little is done to improve the living conditions in the rural community where his land lies. There can be no hesitation in saying that absentee landlordism is the worst system that can possibly be invented or that was ever in practice in any rural community, unless it be that of chattel slavery. If, in addition to absentee landlordism, the lease system is also vicious, that is, if the leases run from year to year rather than for a period of years, the evils become intensified. Neither blight nor pestilence, drought nor flood, war nor famine can more effectually destroy everything that is desirable in rural life than absentee landlordism combined with a bad system of leases. The landlord spends the income which he derives from the land elsewhere, and he has no interest in building up the social life of the community. The tenants move year after year; consequently, they have no interest in building up the community where they happen to live at any one time. Between the absentee landlord and the one-year tenant, the rural community is robbed of everything that makes life worth living.

The mere fact that the landlord lives on his land almost of necessity has a beneficial influence not only upon himself, but upon the whole community. In the first place, the surplus produce of the land in the form of rent is spent on the land where the landowner's home is. Again, since this is the landowner's home, he must necessarily take a vital interest in his own home surroundings. He, therefore, has an interest in the general social conditions of the rural community. He could hardly enjoy life if he allowed even his farm animals to be miserable; much less could he enjoy life if his tenants and the farm laborers were miserable. For his own protection, therefore, if for no other reason, he must take an interest in the general comfort and welfare of the people who live on his land.

Between the ideal landowner who lives on his land, devoting his time and energy to the study of agricultural problems and to advising and helping his tenantry, and, on the other hand, the absentee landowner, who takes no interest in the land except as a source of income, and no interest whatsoever in the general social conditions of the community, there is every gradation. Taking the landlord-and-tenant system as a whole, as we find it in the different parts of the world and as it must be expected to develop, it is a less desirable system than the system under which the farm-worker and farm-owner are the same person. This, however, is quite consistent with the proposition that the landlord-and-tenant system at its best is better than the other system at its worst, but this would not be a fair comparison. The landlord-and-tenant system at its best is certainly no better than the farmer-owned system at its best, whereas the landlord-and-tenant system at its worst is immeasurably worse than anything in the way of farm-ownership.

**The managerial, or capitalistic, system.** The managerial system, sometimes called the capitalistic system, has never developed as have the other 2 systems. The difficulties of administration, especially where labor is scarce and hard to find or restive under discipline, generally discourages the capitalistic farmer, causing him either to sell his land in small parcels to individual proprietors or to lease it to farmers who farm on a small scale and, therefore, have less trouble with the labor problem. The plantation system of the South, as it developed during the days of slavery, gave way under freedom in a characteristic manner. When the labor forces could be held under discipline, the plantation proprietor could make a success of his system; but, when it could not be held under the same rigid discipline, the problem was solved by transferring the free laborer into a small tenant who was, within rather narrow limits, it is true, his own boss and who felt the incentive of profit and loss, prosperity or hunger, as a driving motive. This may be taken as an extreme example, but much the same problem arises wherever the capitalistic proprietor tries to run a large farm with hired help. If he is particularly skillful in the handling of men, or can secure a superintendent who possesses that skill, he may succeed reasonably well. But the general tendency has

been to give up the struggle, as the southern planter did, and either sell his land in small parcels to individual farmers or lease it to them and let them wrestle with the labor problem themselves.

**Advantages of the middle-sized farm.** Aside from the question of ownership, the question of large-scale or small-scale farming is one of great importance. Large-scale farming, of course, tends to become capitalistic. The farmer, whether he be owner or tenant, must, almost of necessity, specialize on the work of superintendence and management and depend upon hired labor for the manual work of the farm. In those extremely large farms where large numbers of men have to be employed, the evidence seems to show that in the long run they are not successful. On the other hand, there is much evidence in favor of what we may call the middle-sized farm, that is, a farm whose acreage must depend greatly upon the type of farming carried on but which, whatever the acreage, involves the hiring of considerable help, at least at certain times of the year. On the other hand, they are not so large but that the farmer himself together with his family performs a fair proportion of the manual labor. Such farms are not characteristically capitalistic. That is to say, the farmer himself actually works with his hands and does not devote himself exclusively to the function of the capitalist. Nor does he hire so many men as to create for himself a distinct labor problem. There is thus preserved a sort of comradeship or fellow-workmanship between employer and employed. Such a farming enterprise gives to the farmer himself scope for the exercising of business talent and the means of earning a larger income for himself and family than he could ordinarily earn if he did not hire considerable help. At the same time, it furnishes an opportunity for the hired man, especially if he be young and ambitious, to serve an apprenticeship under a capable and successful farmer.

As stated above, the acreage of a middle-sized farm must vary with the type of agriculture carried on. In market gardening or truck farming, it might range from 20 to 80 or 100 acres; the value of suitable land is often the limiting factor in this case. In hay, grain, livestock, and cotton farming, from 320 to 640 acres. In cattle ranching, the acreage could of course run up into thousands and tens of thousands.

## The Marketing of Farm Products

There are two very distinct and easily understood methods of selling goods. The first and more primitive is that of selling on inspection; the second and more highly developed, that of selling on grade and reputation. There are, of course, a good many variations and combinations of both methods.

**Selling on inspection.** When the farmer produced for local consumers and could haul his produce directly to the consumer, show it to him, and let him look it over and inspect it, the primitive method of selling on inspection was not so very uneconomical; but when the producer and consumer are so far apart geographically as to make it impossible for them to meet and barter directly with one another, this method becomes very unsatisfactory and uneconomical. The middleman, in one form or another, then becomes a physical necessity; and, if the method of selling by inspection continues, it is pretty certain that there will be a chain of middlemen between the producer and the consumer. That is to say, if every time a product is transferred from one person to another, it has to be inspected or be sold by inspection, a

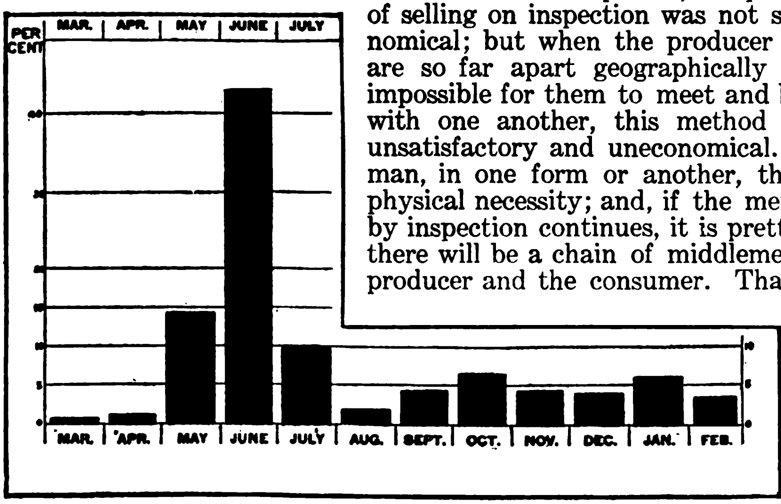



FIG. 77. Relative quantities of butter put into cold storage each month by a Chicago firm. As with eggs (Fig. 76), the largest purchases are made when the supply is greatest and the price lowest. (Wis. Bulletin 209.)

considerable chain of buyers and sellers must necessarily intervene between the producer and the ultimate consumer. It, therefore, becomes increasingly important that the method of selling on grade or reputation should as rapidly as possible replace that of selling on inspection.

**Selling on grade or reputation.** An article is sold on grade or reputation when the buyer does not care to examine it, but is willing to buy it because it has been graded and bears a certain brand or name or guarantee of quality. Where this can be done, large quantities can be transferred from one person to another at a minimum of cost. A producer may sell to a far-distant consumer, if the consumer has sufficient confidence in the producer's ability to grade properly and in his reputation for honesty and responsibility. Without this establishment of mutual confidence, however, this most economical of all methods of buying and selling is an impossibility. Confidence and the honesty which begets that confidence are among the greatest of all labor-savers.

**Grading and standardizing.** Some articles, however, are incapable of being satisfactorily graded and standardized. Breeding animals, for example, must each one sell on its individual merit and can probably never be sold without inspection. But in the large markets of the world, where vast quantities of goods of great value are transferred at a minimum of cost, it will be found that the dealings are always in goods that can be graded and standardized, bought and sold without inspection.

"Whatever differences of opinion may exist with respect to other functions of government, little is said or to be said against coining money and fixing the standards of weights and measures. . . . Both result in great economy of effort in the transfer of goods. . . . Coining the metal merely enables it to pass from hand to hand without the labor of inspection, that is, without weighing it to determine its quantity and without testing it to determine its quality. It 'sells'—if we may speak of selling money—on grade and reputation rather than on inspection. It is the most salable of all commodities, and the fact that it is so standardized as to make inspection unnecessary on the part of the 'buyer' has a great deal to do in giving it its superior salability. By the same process of standardization, any other commodity may approach gold coin in salability, though it may not quite reach it. At least it is safe to say that whenever it can be sold entirely on grade and reputation, and absolutely without inspection, its salability will be enormously increased.

"A short step is taken in the direction of standardizing other commodities when the state establishes uniform standards for determining quantity, that is, when it fixes the standard of weights and measures. Without some uniform system even our present methods of selling would be much more clumsy and wasteful. Every buyer would have to have his own system for determining the quantity of his purchases. . . . Coins are standardized not only as to quantity, but as to quality as well. There is no probability that any government will be called upon to do that which would be analogous to coining money—actually put up other commodities in standardized packages. Something is to be said in favor of fixing standards of quality as well as standards of quantity.

"The reasons in favor of fixing standards of quality, wherever it can be done, are identical with those in favor of fixing standards of measuring quantity. They are all summed up in the superior economy of buying on grade and reputation as compared with buying on inspection. The buyer of an unstandardized commodity may have enough confidence in the seller's system of weights and measures to avoid the necessity of weighing and measuring for himself; but he can scarcely avoid the necessity of inspecting the commodity in order to determine its quality. In some cases, the determination of its quality is easier than that of its quantity, but in other cases it is not. In all cases where quality can be standardized, there is economy of effort. So far as buyers can be saved the trouble of inspection, so far will they be enabled to economize the time and effort involved in making purchases, and so far, also, will the salability of commodities be increased. Whether this will reduce the cost of getting the standardized commodities from producers to consumers, or merely enable the consumers to use their time more advantageously to themselves, may be open to question; but the ultimate economic effects are much the same in either case.

"Not the least among the advantages of a minute division of labor is the fact that each individual can avoid the necessity of being expert in many things and therefore has time to become a specialist in one thing. One of the advantages of the standardization of commodities is that the average consumer can avoid the necessity of being an expert judge of the many articles which he has to purchase. He may, therefore, utilize his time and mental energy in his own special field of work. There is, to be sure, something attractive in the custom of the well-to-do

burgher going to market and selecting with the eye of a connoisseur the various articles needed by his household; but it is wasteful of time and mental energy. When he or his housekeeper is able to order by telephone, without any inspection whatever, and still get what he wants, more time is left for other things.

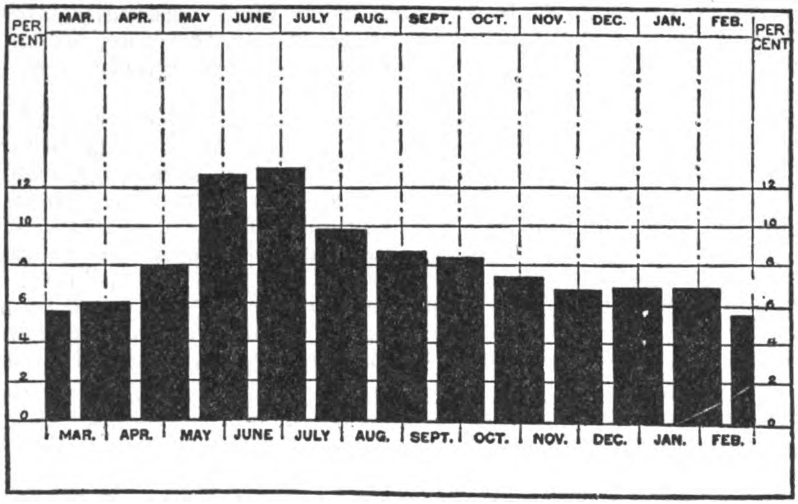



FIG. 78. Winter eggs, milk, etc., have been made possible by careful and persistent breeding, feeding and management; were farmers to relax their vigilance nature would again take charge. This chart shows the relative amounts of milk brought to the University of Wisconsin creamery, and emphasizes the period of greatest natural production. (Wis. Bulletin 209.)

"This will help to explain 2 very distinct tendencies in present-day retail marketing methods. The first is to put more and more articles up into standardized packages. The second is to place more and more dependence upon the retailer, who, in many cases, is coming to regard his customers as clients to whom he is bound to give his own expert service. Both tendencies are designed to save the consumer the trouble of becoming an expert buyer. Neither tendency has, as yet, reduced the cost of getting products from producer to consumer. If the consumer utilizes the time saved in earning a larger income with which to purchase goods, it perhaps does him as much good as it would if these tendencies merely reduced the price of commodities.

"One reason why these tendencies merely save the time of the consumer rather than reduce the cost of getting the products to him is, that the standardization takes place only in the last stage of the process, that is, just before the commodities reach the consumer. In order to reduce materially the spread between the prices which the producer gets and the consumer pays, standardization must take place early in the process.

"A good illustration of the effect of standardizing a product early in the process of getting it from the producer to the consumer is found in the marketing of California oranges. They are graded and standardized as soon as they leave the orchards. All subsequent inspection is therefore unnecessary, and the cost of getting them to the consumer is reduced practically to the physical cost of haulage and handling. This has notably reduced the spread between the two prices. Many other commodities, such as wheat, cotton, pig iron, and coal, are largely sold on grade rather than on inspection. In these cases, the government has had very little to do with the standardization. Two recent acts of Congress, however, have brought the government definitely into this field as the fixer of standards of quality. These are the Cotton Futures Act and the Grain Standards Act. Both give the Secretary of Agriculture power to establish grades and to enforce their use in the regular channels of trade. A number of states, also, have passed grading laws of various kinds."*

## Financing the Farmer

In order that the capital of the country should yield its maximum service it should distribute itself among the different fields in proportion to its opportunity for profitable use. There is a close analogy between this principle governing the distribution of capital and the principle which governs the distribution of any other commodity that is useful in production. Let us take the use of water in irrigation. A limited supply of water in an irrigated region

*From "Standardization in Marketing," by T. N. CARVER, in *Quarterly Journal of Economics*, Vol. XXXI, No. 2, February, 1917.

will yield a larger total product if it is restricted to such areas as yield the maximum crops and, roughly, in proportion to the productivity of the different fields. If, for example, one field will yield 50 bushels of wheat to the acre, whereas another will yield only 25, and there is not water enough for both, it is much better for the community that all the water should go to the 50-bushel field. To allow part of it to go on the 25-bushel land, thereby cutting off the supply of some of the 50-bushel land, would be a distinct waste of this valuable resource. Again, to allow a farmer who with good land could only produce 25 bushels to the acre to have water, and thereby deprive some other farmer who with land of equal quality could produce 50 bushels to the acre, would involve just as great a loss or waste of water. In the competitive process it is pretty certain that the 50-bushel farmer could afford to pay a higher price for the water than the 25-bushel farmer; and it would be to the interest of the community that he should do so, just as truly as it would be to the interest of the community that the farmer with the 50-bushel land should buy the limited supply of water, thus depriving him whose land is capable of procducing only 25 bushels to the acre.

The same law applies to the distribution of capital. It should flow into the different fields of enterprise and production according to the degree of productivity found in each field. If agriculture is so oversupplied with capital that farmers cannot afford to pay more, let us say, than 3 per cent for it, whereas other business men can afford to pay 5 or 6 per cent, obviously more capital ought to go into other lines of business and less into agriculture. But if farmers can afford to pay 6 or 7 per cent, whereas other lines of business can afford to pay only 4 or 5 per cent, it is important that increasing quantities should be diverted to agriculture.

**Standard forms of agricultural securities needed.** If there were no disturbing factors in the laws of the market, capital would tend to distribute itself between the two fields of enterprise, agriculture and urban business, in such proportions as would enable it to yield approximately equal rates of interest in both fields. But, if there are disturbing factors, it may flow in undue proportions into one field instead of distributing itself properly between both. There have, undoubtedly, been disturbing factors in our national economy which have hindered the flow of capital into agriculture and tended to divert it into other lines of business even though at lower rates of interest. One of the most important of these has been the lack of standard forms of agricultural security. The principle (explained under "The Marketing of Farm Products") of selling on grade rather than on inspection, applies just as well to the selling of securities as to the selling of material commodities. A security that can be standardized and sold on grade will sell much more readily than one which can only be sold on inspection. The ordinary industrial securities tend to become standardized and to sell on grade. The result is that the inexpert buyer may safely invest his capital in any of them. The form of security offered by the agricultural industry in the past has been the farm mortgage. This is unstandardized and cannot be sold except on inspection. The inexpert investor or the investor who is too busy to take the time to inspect the farm and the title to the land, and to investigate other factors affecting the security does not dare to buy a farm mortgage. Only those few who are favorably situated for the work of inspection and who have some little expertness in it are in a position to buy the form of security which the farmer has had to offer. But any one who has managed to save up $100 or so may invest in some form of industrial security without much risk. This has seriously hindered the flow of capital into agricultural industries.

Various private organizations have intervened in order to fill the gap. The large company with a good reputation for solvency can put its own experts into the field to inspect farms, titles, etc., and to buy farm mortgages. When thus inspected and bought, they are excellent security; but they would be very poor security for the investor who had neither time nor ability to do the inspecting. This company, however, issues its own securities on its own reputation, selling them to the general public. These securities possess one great advantage over the mortgage, that of salability; and this salability is due to the fact that they are sold on grade and reputation rather than on inspection. The inexpert buyer will buy these securities when he would not buy individual farm mortgages.

This, however, has only partially met the difficulty. The Federal Farm Loan Act is the first constructive piece of national legislation dealing with the problem of properly financing the farmer. The securities of the Farm Land Banks, being under the supervision and inspection of the Federal government, will sell on grade and reputation rather than on inspection. The general investing public may, therefore, buy this form of security with the same confidence with which it now buys other standardized industrial securities. This, in turn, will enable the capital of the country to flow into agriculture with the same freedom with which it now flows into other industries. The Farm Land Banks, through the organization of local farm loan associations and through their own inspectors and appraisers, will become expert buyers of the unstandardized mortgages. Thus the farmer's unstandardized security will be virtually transformed into a standardized security before it is offered to the general public. That is to say, when the Farm Land Bank accumulates a certain number of farm mortgages it may issue its own bonds with these mortgages as security and offer these bonds in standardized form to the investing public. This will put the farmer on an equal footing with the urban business man in the effort to secure capital for his business.

### How to Get and Use Credit

"There is no magic about credit. It is a powerful agency for good in the hands of those who know how to use it. So is dynamite. They are about equally dangerous in the hands of those who do not understand them. Speaking broadly, there are probably almost as many farmers in this country who are suffering from too much as from too little credit. Many a farmer would be better off to-day if he had never had a chance to borrow money at all, or go into debt for the things which he bought. However, that is no reason why those farmers who do know how to use credit should not have it.

"There is no mystery about credit or capital. Capital consists of tools and equipment, though sometimes we speak of it as though it were the money necessary to buy the tools and equipment. Capital and land are the factors which call for investment by the farmer. Thus the large use of capital in farming has come because of the invention of agricultural machinery. When farming was done with a few very simple tools, most of which were made either by the farmer himself or by the local blacksmith, capital did not play a large part in agriculture. . . . It did not take much money to buy all the equipment the farmer needed or knew how to use. The purchase of land was the only thing requiring much money, and land in this country was either free or very cheap. Therefore, very little money was required for a start in agriculture. At the present time, not only is the price of land rising, but the equipment of a farm requires more capital because of the increased use of improved machinery.

"Capital is brought into existence in only one way—that is, by consuming less than is produced. If one has a dollar, one can spend it either for an article of consumption, say confectionery, or for an article of production, say a spade. He who buys a spade becomes a capitalist to the amount of the value of the spade—that is, he becomes an owner of tools. The process is precisely the same, whether the amount in question is a dollar or a million dollars. If he does not have the dollar, his only chance of getting the spade is either to borrow it or borrow the money with which to buy it. That is, he must use credit. Again, the process is precisely the same, whether the amount be a dollar or a million dollars.

"There are, therefore, only two ways of securing capital for the equipment of a farm. One is to accumulate it oneself, by consuming less than one produces; the other is to borrow it. The advantage of borrowing is that one does not have to wait so long to get possession of the tools and equipment. One can get them at once and make them produce the means of paying for themselves. Without them, the farmer's production might be so low as to make it difficult ever to accumulate enough with which to buy them.

"Shortsighted people, however, who do not realize how inexorably the time of payment arrives, who do not know how rapidly tools wear out and have to be replaced, or who do not keep accounts in order that they may tell exactly where they stand financially, will do well to avoid borrowing. Debts have to be paid with deadly certainty, and they who do not have the wherewithal when the day of reckoning arrives, become bankrupt with equal certainty.

"On the other hand, there is nothing disgraceful about borrowing for productive purposes. The feeling that it is not quite respectable to go into debt has grown out of the old habit of borrowing to pay living expenses. That was regarded, perhaps rightly, as a sign of incompetency. It was then natural that men should not like to have their neighbors know that they had to borrow money. But to borrow for a genuinely productive purpose, for a purpose which will bring you in more than enough to pay off your debt, principal and interest, is a profitable enterprise. It shows business sagacity and courage, and is not a thing to be ashamed of. But it cannot be too much emphasized that the would-be borrower must calculate very carefully and be sure that the enterprise is productive before he goes into debt.

"In the payment of a debt it is not the interest, but the principal, which gives the greatest trouble, except where interest rates are exorbitant. If a man borrows $100 for a year at 7 per cent, he has to pay, at the end of the year, $107. If he borrows at 5 per cent, he has to pay $105. The difference is $2. Now, $2 is not to be despised. Good business consists, in large part, in looking after just such items as this. Nevertheless, it is only a little harder to pay $107 than to pay $105. The point is that the principal is the same in either case, and it is the principal which gives the greatest trouble.

"The reason it has seemed necessary to emphasize this elementary fact is that many people seem to imagine that if interest on farm loans can be reduced from 7 per cent to 5 per cent, or from 6 per cent to 4 per cent, conditions will be made easy for the farmers. It is important that interest rates be lowered wherever it is economically possible, but it is vastly more important that farmers should learn how to pay back the principal easily. The only way to do this is to use the money borrowed in such a way as to put one in possession of the means of repayment. If the $100 which a man borrows is spent for fertilizer, which adds $125 to the value of his crop, he should not find any great difficulty in repaying the loan, both principal and interest. If he uses it in such a way as to add only $75 to his crop, he will have some difficulty in repaying the principal, to say nothing of the interest. An unproductive enterprise is not a safe basis for borrowing under any conditions.

"The first and most important rule to be observed, therefore, in the use of farm credit is to make sure that it is for a productive purpose, that is to say, *make sure that the purpose for which the borrowed money is to be used will produce a return greater than needed to pay the debt.* Except in extreme cases, it is bad policy to borrow in order to purchase anything which will not help to pay for itself. As a rule, the purchase of these things should be postponed until the farmer has accumulated the wherewithal out of his own earnings.

"But if he borrows money to buy fertilizer and agrees to repay the loan before his crop has been harvested and sold, he may have difficulty in repaying it. One in such a predicament has three possibilities open to him. He may receive money from some other source at the time the loan falls due; he may get the loan extended or the note renewed; or he may be sold out by his creditor. The first is not altogether desirable, because it violates an important principle of business management, namely, that each part of the business shall provide the means of paying its own expenses. The second is undesirable, because it puts him in the position of requesting a favor of his creditor, whereas all business arrangements between man and man ought to be so clear and so definite that neither shall need to ask special favors of the other. The third needs no comment.

"This brings us to the second rule to be observed in the use of farm credit. The contract should provide for the repayment of the principal at the most convenient time; that is, when the farmer is most likely to have the means wherewith to repay it.

"The third rule is closely related to the second. It has to do with the duration of the loan. If a man borrows to buy fertilizer which is to be used up in one year, the loan ought not to run for more than a year. If he is not able to pay the loan with his first crop, he will never be in a position to pay it, unless he draws upon some other source for the money. This violates the first rule. Again, it should not be for a shorter period than the growing season of the crop; for that would violate the second rule. If he borrows for the purpose of buying a twine-binder which will help in the harvesting of several grain crops, each crop should not only pay the an-

nual interest charge, but a part of the principal as well. A small loan of this kind, for an investment which lasts only a few years, may not give much trouble and may not require any special method of repayment. But a heavy loan, for the purchase of land or the making of costly and durable improvements, may lay a considerable financial strain upon the farmer. Any method which will relieve that strain is, therefore, important.

"In order to reduce the strain as much as possible, the loan should be for a long period of time. In no case, of course, as stated above, should the loan outlast the improvement. If the borrower wants the money to build a silo, and the silo will last 10 years, the loan should not be for more than 10 years. It is better to err on the safe side, if at all, and pay the debt off in less than 10 years rather than to let it run too long. If the silo will not pay for itself in that time, it never will. On the other hand, it can scarcely be expected to pay for itself in one or two years. Unless the borrower has other resources, it would be a financial strain if his debt had to be paid so soon. *The length of time the debt is to run should have a close relation to the productive life of the improvement for which the money is borrowed.* This will do away with the necessity of having the loan frequently renewed, and it will free the borrower from subjection to an unscrupulous lender who might refuse to renew a short-time loan and insist on foreclosure.

"The fourth rule is that *provision should be made in the long-time loan for the gradual reduction of the principal.* There are two well-recognized ways of doing this. One is to provide in the note that, on any interest date, the borrower may, if he so desires, repay a part of the principal. As the principal is gradually reduced, the annual interest charge is likewise reduced, and by paying the same sum annually, the debt is gradually wiped out. Another method is to provide in the note itself for a definite rate of amortization by fixed annual or semiannual payments. Each of these fixed payments not only pays the interest, but a small part of the principal besides, eventually wiping it out completely. Farmers are strongly advised, in all long-time loans, to insist on one or the other of these methods of repayment. It may be necessary to organize and work together in order to secure these and other favorable terms.

"The fifth rule is that *as low interest rates as possible should be secured.* While this is obvious enough, it is apparently not quite clear to a good many farmers just how to secure low interest rates. Interest rates, like prices in general, depend upon the law of supply and demand. When there is more loanable capital in a community than is wanted by the borrowers of that community, the rate of interest is low and the borrowers can dictate terms. When there is less loanable capital than is wanted by borrowers, interest is high and the lenders dictate terms. Obviously, therefore, it is to the interest of the borrowers to increase the number of lenders, or, at least, to increase the amount of loanable capital in their community. The way to increase the supply of loanable capital is not to denounce lenders and hold them up to public hatred. That is like throwing clubs at chickens, to cure them of shyness and make them come when they are called. The right way is just the opposite of that; it is to make the neighborhood attractive to lenders, so that they will be anxious to come. Then the borrowers will be able to secure favorable terms. So long as lenders are hated, so long as borrowers habitually try to beat the lenders and force them to resort to legal proceedings to collect, just so long will the right kind of lenders avoid such a community, interest rates will be high, terms unfavorable, and foreclosures frequent. The only kind of lenders who will go to such a community are the loan sharks, who go in for the purpose of taking advantage of high interest rates and who watch for chances to foreclose mortgages.

"The point to remember is that the farmers have it within their power, to a large extent, to remedy these conditions themselves, though it may take some careful planning and hard work. In the first place, they must disabuse their minds of the notion that tangible property, such as land, furnishes the best security in the world. The business ability and character of the borrower are of even greater importance in such transactions than the value of the land he may own. Where farmers are known to be capable of paying their debts, and willing to do so promptly and without legal proceedings, there credit conditions are good, because the right kind of lenders are attracted. Lenders of the right kind do not like to foreclose mortgages or resort to any form of legal procedure. They will avoid any neighborhood where such things occur frequently, leaving it to others less considerate. The right kind of money lender merely wants his principal back, together with the stipulated rate of interest. Where these are assured to him without the vexation of legal procedure, he will go.

"It must be admitted, however, that one farmer can do very little, when working alone, to give his neighborhood a better financial reputation, or to attract the right kind of lenders. This is a problem which must be worked out by the whole community, or, at least, by a considerable group of men. If ten men cannot be found in a community who have confidence in one another, how can they hope to find lenders from the outside who will have confidence enough in that community to risk lending money there?"*

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* From "How to Use Farm Credit," by T. N. CARVER, in Farmers' Bulletin 593, June 3, 1914.

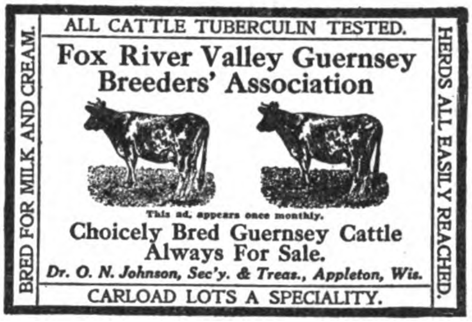



**Fig. 79.** Community breeding and advertising make for better farms, better farmers, better livestock and better business

## CHAPTER 9

# The Neighborhood as a Business Asset

*By* William L. Nelson, *farmer, agricultural writer and U. S. Congressman from Missouri; formerly of the Extension Department of the College of Agriculture of the University of Missouri. For 10 years Assistant Secretary of the Missouri State Board of Agriculture; author of the first farm name registration law; contributor to the "Breeder's Gazette" and other farm journals; and, throughout his life, a practical, successful farmer and a friend, confidant and helper of other farmers. Born and reared on a farm in one of the richest sections of one of our greatest farm states, he has traveled and observed conditions over much of the country, especially those conditions that constitute and influence the social life of farm communities. The men and women and children that live on farms are no less human than those who live in cities; they form a part—and a big, important part—of society; and their social development must be sound and well-balanced if the foundations of the nation's prosperity are to stand unshaken. The life of the rural community, and its organization in the neighborhood, is a tremendous but all too often overlooked factor in the success or failure of the individual farms that make it up. Mr. Nelson writes of a fundamental factor in the business of farming; and from long experience and close observation, he knows whereof he writes.*—Editor.

THE neighbor is the "near-dweller." In the long ago, when our language was taking form, the "bour" section of the double word, as "neighbour" (now spelt without the u), meant "farmer" or "rustic." It was then that people settled near together for mutual protection and benefits. Thus they became near dwellers or neighbors.

**The early neighborhood.** The custom of forming agricultural villages or neighborhoods was first known in Asia and Europe, and was brought to America by the first white settlers who came to make their homes in the new land. The causes that led to the founding and growth of neighborhoods were much the same in both hemispheres. In the Old World there was, for a long time, need of protection from bands of robbers, just as the first settlers in America found it necessary to build their homes close together, perhaps around a stockade or fort, as protection from the Indians. In some sections, wild animals, also, endangered the lives of settlers whose homes were far apart.

There were additional reasons why, in those early days, neighborhoods were formed. The lone settler could not enjoy the privileges and advantages of church and school. With all the people coöperating, however, the neighborhood might have its preacher or priest, together with its physician to look af-

ter the ills of the body. There were, also, advantages which came of neighborhood barter and trade. So, even in that early day, the neighborhood became of considerable importance as a business asset.

**The new neighborhood.** To-day, the neighborhood is not limited to such narrow boundaries as was the neighborhood of the past. This is due largely to improved methods of getting about by land and water, to the building of better highways, and to the use of the automobile. The twentieth-century "day's journey" differs greatly from that of Biblical times.

These differences, though, are not greater than the changes in the neighborhood itself. Where, in the olden times, only near neighbors traded with one another, trade is now carried on between widely separated neighborhoods, and between distant states and countries. Hence it is the world demand, rather than the neighborhood supply, that fixes prices.

**No man lives unto himself.** The farmer whose home may be in some out-of-the-way neighborhood is interested in the wool clip of Australia, the beef supply of Argentina, and the wheat crop of Russia. The people of those countries buy and sell in the same markets that he does. Consequently, he needs to know something of them and of their crops. Working alone, it would not be possible for him to get much information, but, through community effort and the joining of neighborhood forces with still larger organizations, he gets market reports telling him just what he wants to know about crops, yields, and prices. Such things multiplied many times over prove how important is the neighborhood.

**What makes a good neighborhood?** How often do we hear said of one community, "That is a good neighborhood," while of another the comment is made, "I would not care for that neighborhood." What, then, are the things that make us prefer one neighborhood to another? What are some of the ways in which neighborhoods differ? If about to choose a location for a farm home, what are some of the things for which we should look? In other words, what is in one neighborhood that adds to the value of property by making people want it, and what is it in another neighborhood that produces just the opposite effect?

Remembering that no country produces a better crop than its inhabitants, we, first of all, turn our attention to the people. Taking for granted that we, ourselves, are progressive, law-abiding, and generally desirable citizens, we may ask, "Are they our kind of folks?" Are their ideas and ideals, their moral standards, their customs and manners somewhat like those we have chosen for ourselves? These are not the things that are usually spoken of by the real-estate agent or promoter; but, especially to the man with a family, they are of more importance than soil fertility or markets. Land and buildings do not make a neighborhood any more than brick and mortar make a home. So, in trying to find out about the neighborhood, we ask about other things. Are the standards of the people right? What of Sunday observance, of respect for law, of temperance and frugality, and of patriotism? The answers to these questions may help us to decide whether or not the neighborhood is one in which we would care to live. Nobody wishes to settle in a community where feuds and fusses are common or where serious factions exist among the farmers. In brief, nobody wants to buy a lawsuit with his land.

Because all of us are more or less influenced by the people among whom we live, we are interested in the ideals of the neighborhood. Are they high or low? If the people believe in high ideals, in the right, do they stop with just believing or are they willing to fight for the right? These are proper questions, for long-established neighborhood customs and viewpoints are hard to change, at best.

Is the neighborhood one of home owners or is it one of city landlords and of renters whose leases run only from year to year?

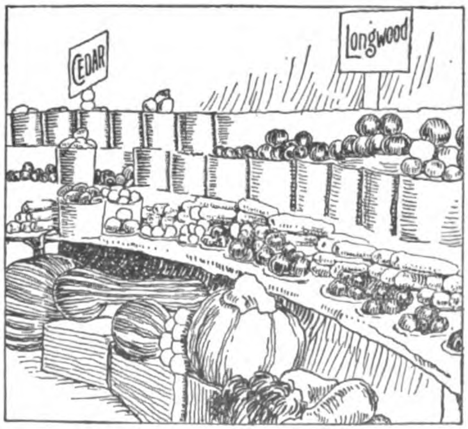



FIG. 80. By competition at fairs and rural meetings, neighborhoods develop increased ability to progress, as well as greater friendship and unity of purpose.

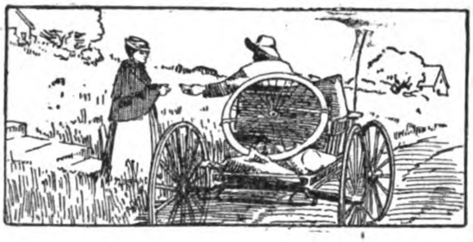


FIG. 81. The telephone, the automobile, the rural free delivery—everything that keeps one family in touch with another, helps along the spirit of neighborliness.

This is an important matter. In a neighborhood where most of the people own their own homes, a larger proportion are apt to be willing to contribute of their means toward the public good. This is because there is a prospect that they will be able to share in these things for a longer time. Again, men who live in the same place for a term of years are likely to be more able to help neighborhood upbuilding than are those who are always on the move.

What of the standards that the community has set us as regards success? Is wealth, as represented in land and bank stock, the only standard by which men are measured? Are there signs of thrift and industry, or do the looks of things indicate lack of enterprise on the part of the people?

The general appearance of farms and farmsteads in any community is a pretty true index to the lives of the people. It is also true that appearances have much to do with the actual values, as measured in dollars and cents. The well-improved, carefully kept farm loses in value when surrounded by other farms where the fences are poor, the fencerows weed-grown, the outbuildings old, and the farmhouses in need of paint.

In our best communities, in the neighborhoods that are real business assets, there has come about a big change on the part of the farmer. He is no longer willing to have his barn roof converted into a glaring billboard, or the sides of his buildings plastered with circus posters. He objects to having his fences or gates, or even the fine old trees in front of the farm, turned into free advertising agencies.

## Profit Through Neighborhood Work

Wherever there is a neighborhood of named farms there is a community of thrifty farmers. There carelessness is giving place to care. There the people take pride in their business.

**The farm name.** How much better that the farm be named, and that its name be plainly and neatly displayed on mail box or front gate, than that the barn roof be covered with box-car letters advertising soap, tobacco, or other commodities for sale in the city. Somehow, when one sees a neighborhood in which the roofs of many barns are so painted, he comes to the conclusion that the farmers of that community are either too poor to paint their own buildings or that they are lacking in pride. If they must thus advertise, the commodities should be at least such as are produced on the farms of the neighborhood, rather than products offered for sale in the city. Is there profit in a farm name? Yes. First of all as a trade mark; the consumer, when he finds the goods satisfactory, looks to see where the product came from and by whom it was packed. The next time he comes to buy, he looks for the name of the farm and of the community from which the product came.

FIG. 82. A good farm deserves a handsome, dignified, hospitable entrance.

Agriculturual and horticultural displays made under the farm names, joined with the neighborhood name, constitute a valuable and attractive method of advertising. If, for instance, a farmer is working to build up a trade in country hams, somewhere on each ham, or on the package in which it is delivered, the farm name should be printed or stenciled. The country woman who has a few select city customers for butter can well afford to wrap each pound in oiled paper upon which is printed the farm name, together with the neighborhood name. The best country produce easily commands a premium which it is no trouble for the producer to get, if only he will make the consumer familiar with the name of the factory—that is, the farm and its location.

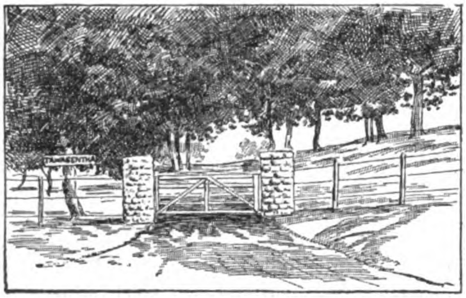


Fig. 83. The farm entrance—bearing the farm name—should be simple, dignified and in keeping with the place and its surroundings. The name of this farm would look better on a post than nailed to the tree.

**Neighborhood names.** What has been said as to farm names applies also to neighborhood names. It is worth while for a neighborhood to build a reputation for the quality of its products, whatever these may be, and to dispose of them under the community name. Some communities have capitalized the neighborhood name to such an extent that in cross-country travel we sometimes find it prominently displayed on the highway. In one instance stone markers have been erected on the main traveled road and at points generally accepted as the boundaries of the neighborhood. Another community has erected near its central point and over a well-kept highway, a large arch, featuring the neighborhood name. Where there is a neighborhood house or community hall—and happily these are becoming more common—there is no better site for giving prominence to the neighborhood name.

Great wealth is not necessary in the building of an attractive, inviting neighborhood. The big thing is for folks in the neighborhood to get together and work out their own problems. They must also understand that much depends upon each farmer working on his own farm and in his own way. The farmer who feels a real pride in his place is a community asset, and aids in making his neighborhood a desirable place in which to live.

**Community pride.** In a certain community in a western state, the people have, for a number of years, been working to make their neighborhood better and more beautiful. Everybody is proud of the neighborhood. This is shown in many ways. For instance, each buggy or automobile that goes to the city several miles distant bears a pennant showing the neighborhood name. Local pride, as seen in well-kept farm homes, has largely been responsible for a big advance in land values during the last 10 years. It should be borne in mind, however, that one farmer alone could have accomplished but little in such a movement. Big things are possible only where the members of the neighborhood join forces, where the people get together and work together.

**A farm clean-up day.** There is a close connection between community pride and cleanliness. This fact may cause a neighborhood to set aside a farm clean-up day. Once established, such a day becomes the centre of a community campaign for cleanliness.

On farm clean-up day, each farm in the neighborhood should be "combed and brushed," so to speak. The breeding places of flies should be destroyed and filth and refuse of all kinds removed, for flies and filth are the forerunners of fever. It will do but little good to "swat the fly," if the breeding places are left undisturbed; or to destroy a few mosquitoes and leave undrained the stagnant pool behind the barn. And these campaigns for health and cleanliness, if they are to do the most good, must be community movements. The mansion may be ever so sanitary, but it will help but little if in the tenant house or the home of a near neighbor dirt and filth are spreading diseases, or if the food and water supply of the neighborhood is such as to endanger health.

**Coöperative buying and selling.** As a selling unit, the neighborhood has many advantages over the individual farm. Principal among these is the possibility of a larger volume of business. The farm of average size is naturally limited in its output. For this reason, it is not profitable to advertise on a big scale. On the other hand, where the farmers of an entire neighborhood join together in the production and sale of a common product, it is possible to increase the volume so that advertising in a rather large way will pay. A saving can also be made in buying crates, boxes, barrels, or other material. Such neighborhood coöperation generally means the formation of an association, especially if the product is a perishable one, such as fruit, berries, or truck. This association, under proper management, guarantees the quality and grade of the goods.

"Boost your neighbor, boost your friend;  
Boost the church that you attend;  
Boost the farm on which you're dwelling;  
Boost the goods that you are selling;  
Boost the people around about you;  
They *can* get along without you;  
But success will quicker find them,  
If they know you are behind them;  
Boost for every forward movement;  
Boost for every new improvement;  
Boost the stranger and the neighbor;  
Boost the man for whom you labor;  
Cease to be a chronic knocker;  
Cease to be a progress-blocker;  
If you'd make your township better,  
Boost it to the final letter.  
Stop your knocking! Boost!"

In other words, it leads to the establishment of certain standards such as must be made the basis of all permanent and profitable selling.

There are, in the United States, thousands of places where both soil and climate are favorable for fruit growing, but where, because the neighborhood has not yet been developed, fruit growing is now unprofitable. With the coming of more inhabitants and the growth of the neighborhood idea, fruit growers' and shippers' associations will be formed, just as they have been wherever fruit is now profitably grown on an extensive scale.

**Neighborhood work in seed growing and livestock breeding.** The neighborhood makes possible and profitable the production and sale of purebred seed and registered livestock. One farmer cannot successfully grow a certain variety of corn if his near neighbor is growing another kind; for the result will be a mixture not fit for seed, but valuable only as a commercial product.

It was once a common belief on the part of many beginners in livestock breeding that it would be to their advantage to take up some breed of stock not before found on the farms of the neighborhood. This idea was a mistaken one. Community, or neighborhood breeding is best; for, in this, those interested in the same breed of stock work together rather than against one another. For instance, where the neighborhood is small, the farmers may profitably join in buying a sire of such worth and merit as an individual farmer or breeder could not afford to buy. In a larger neighborhood, the exchange of sires of known worth may prove a big advantage.

In the sale of surplus stock, the breeder who is located in a neighborhood where good animals are to be had in large numbers finds it much easier to make sales. Buyers are attracted to such a community. The farmer or breeder who is in the market for but one animal, goes there knowing that he can find what he wants without loss of time and money in looking over herds that are widely scattered. If, perchance, he should pay a little more for an animal of much better quality—and community breeding generally means better breeding—he has the satisfaction of knowing that he has invested his money in a good, registered animal rather than in railroad tickets and hotel bills. As to sales, however, the greatest advantage, perhaps, lies in the possibility of attracting the big buyer, the carlot purchaser, who from time to time will visit the neighborhood and buy practically all the surplus stock of the quality that he can use in filling his orders.

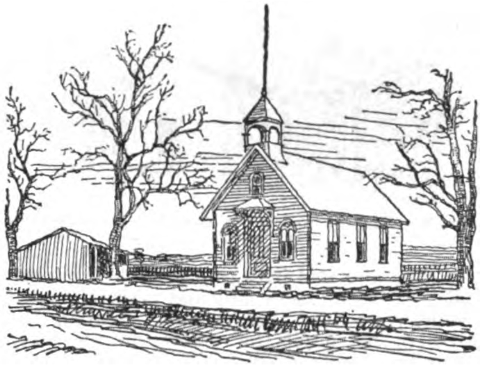


FIG. 84. Every neighborhood should have its meeting place. Many halls, such as this one in Burke township, Wisconsin, built originally for political or religious purposes, now unused, could be rededicated to such service.

Thus, measured by the commercial standard alone, the neighborhood has a decided advantage as a business asset. There are other and, perhaps, greater advantages.

## Other Neighborhood Advantages

**Good schools.** A good neighborhood means good schools. For want of schools, for proper educational advantages for the children, men and women have often been slow to push out into new lands. Denied good schools for their children, fathers and mothers have left desirable country homes and moved to towns or cities, thus making the country poorer, often without making their own lives as rich and useful as they would have been in the country.

FIG. 85. The children of the neighborhood are both an asset and a responsibility. There should be playgrounds where they, too, can develop community spirit.

One of the first questions asked by the thoughtful man about to purchase a home in a rural community or neighborhood is, "What kind of schools has it?" Well may such a question be asked. What of the teacher? Is he capable, experienced, well paid? Are his ideals and viewpoints such as to make

FIG. 86. Such a school as this bespeaks a poor community, whereas—

for sane and real lives on the part of his pupils? Does he appreciate and praise the open country, or is he, day after day, shaping the lives of his pupils for careers in the city? Does he point out the opportunities in the country, or does he see in the growing things about him, in the animals of forest and field, nothing of interest, and in the country nothing worth while? Is the schoolhouse a plain, unpainted structure of "box-car" architecture? Or is this more-than-half-the-year home of the boys and girls of the community an attractive building, clean, comfortable, and inviting? What of the grounds? Is the playground weed-grown or covered with brush and refuse, or are there beautiful shade trees and shrubbery and inviting green grass, with room for the children to play? All these are vital neighborhood questions. They deal directly with the community's best crop—its children. In the schoolhouse and its surroundings we learn of the estimate which the neighborhood places upon itself. Always, too, we must remember that good schools do not come by accident, but represent the results of the best neighborhood sentiment put into action.

As communities progress, as better roads come, we find a growing demand for the rural high school and the consolidated district school. These are distinct neighborhood enterprises. They add to the value of farms, and stop one of the greatest sources of waste and expense, namely, that of sending country boys and girls to town for their education. The first expense in such a move, that of board and tuition, while heavy, is but a small one. The real expense comes in the loss of the boy and girl from the home community.

**The church.** Standing in close relationship with the country school is the country church. Practically all that has been said of the school in connection with the rural community is equally true of the country church. There are those who mourn the passing of the old-time church which was strong in creed, and which made for strong manhood and noble womanhood, but which gave little thought to community life as a whole. That church, which so ably served its people in its day and age—a day and age which are of the past—is perhaps not prospering as it once did. But in its place there is being developed a new church, in which there is not less of Christian spirit, but more of community interests. The people of such a church are no longer satisfied with a mere preacher, but want a resident pastor. This pastor, while none the less consecrated than were the pastors of other days, will be in closer touch with the people whom he serves. Naturally, this new rural church, with its larger vision and more complete service, will become the centre of community activities. A description of one such church is the story of many.

In a prosperous agricultural community in one of the leading corn-belt states is Harmony Church. This church serves the entire neighborhood. It is the centre of the life of all the community. The people of the congregation contribute liberally to every worthy cause. The church has a part in the important every-day life of the community. The pastor is more than a preacher; he is the community leader. The church has its young people's societies, its glee club, its orchestra, its baseball club, and even its trap-shooting contests—the latter using "clay pigeons," not live birds. Once each year there is held a great community home-coming, which has grown in numbers until as many as 3,000 people have gathered on the grounds at one time. Under the direction and leadership of the pastor, who, as has been said, is more than a preacher, the community has prospered as never before. Farms have been built up, residences and buildings have been improved, the entire community has become inviting in appearance, land values have greatly increased, and community breeding of livestock is being successfully carried on. Everywhere there are unmistakable signs of thrift and progress. In brief, this community is contributing to practically every cause except the courts. Not in five years has one of the citizens of this neighborhood been engaged in a lawsuit. The township is to-day without a local law-enforcing officer; it needs none. Incidentally, it may be said that the roads of this community are the best in the county.

One of the more recent projects of the Harmony community is the organization of the Harmony Shorthorn Breeders' Association. The 26 members of the organization—and to be eligible to membership in this special effort, one is required to live within 5 miles of

FIG. 87. A neat, roomy, well-kept school does more for its pupils. and also for its neghborhood

the church—have acquired 100 registered Shorthorns and 200 high-grade cows. Twelve registered bulls have been placed in service, although, as a matter of convenience, they are owned privately by a group of individuals within the circle.

This Shorthorn circle, which is but one of various interests which the community is encouraging, is a logical plan for the improvement of the cattle stock in the community. By this method prospective buyers are more readily attracted because they have larger numbers of one breed from which to make selections. The advertising and other expenses can be held to the minimum and at the same time the best of results can be assured.

This little church community is, therefore, even in this one respect, undertaking a very important and useful work. In too many communities do we find the stock representing a half dozen or more different breeds, the result being that coöperation is almost eliminated; the individual breeders must fight their own battles and, with only a few head of salable stock, they are at a disadvantage as regards attracting buyers. There is now a growing inclination to adopt one breed in a community and to adhere to that breed; the results are distinctly gratifying.

**Roads.** There is a close connection between good roads and agriculture. Without good roads the best work of school, church, or commercial body is not possible. We may build modern homes on the finest of farms; but, if to live in them means to be cut off from the world, even for a few months during the winter and early spring seasons, men and women will still turn to the crowded city. In the best country communities, the conclusion has been reached that good roads, good sense, and good business go together. While roads cost money, they make money. They may, for a little while, put a burden on the farmer's pocketbook, but they put a lasting value on his land. What is of greater importance, they create a healthy social life, and, by linking together the farm, the church, and the school, make for educational and religious uplift. In the building of roads the greatest good comes

FIG. 88. The roads are both the measure and the result of neighborhood spirit. Poor roads and poor homes go together—

FIG. 89. Whereas a good road is very likely to be bordered by good farms whose owners take pride in their surroundings.

through community or neighborhood effort. Good roads are likewise one of the greatest assets that any community can possess. They are more than connecting links between farms. They are the arteries through which flows the red lifeblood of the country, without which no town can long keep alive. Thus do good roads, connecting the country community and the nearby city, become of value to both the urban and the rural people.

Nothing, perhaps, could possibly add more to the attractiveness of life in the open country or subtract more from the common objections urged against it, than good roads. The community that is without good roads is without rural free delivery mail service, one of the greatest agencies in the betterment of farm life. The good road brings with it a feeling of comfort and safety. Should sudden sickness or an accident make it necessary to call a physician, the value of a good road leading to the farm home could not be measured in dollars.

The profitable marketing of crops demands good roads. The manufacturer seeking a location takes note of the railroads and other means of transportation. Because every farm is a factory and because most of the products of the farm must be moved to the consuming centres, the wise farmer thinks, first of all, of the wagon roads. The average cost of hauling farm products in the United States has been figured at 23 cents per ton mile, while on improved roads the cost is but 10 or 11 cents. With an average haul of 9 miles, and with a ton load, the actual saving on every trip over a good road is more than $2. The neighborhood that is connected with the market or shipping point by good roads has a big advantage over the one where the farmers have long mud hauls, or where loads must be drawn over steep hills. Neighborhood action, which alone makes good roads possible, represents practical benefits which may be measured in terms of dollars and cents.

Until communities have been developed, until neighborhoods have taken form, there can be no road building of a permanent character. The early settler traveled the trails, the pioneer put up with paths; but the farm-

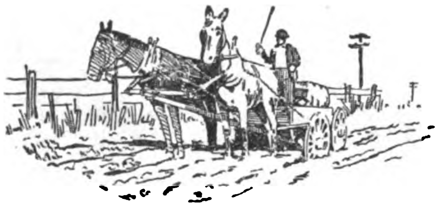


FIG. 90. Good roads have a real cash value. Here the difference is as one bale to twelve. They have an equally striking and important effect on the moral and mental characters of the people who use them

er in the prosperous, progressive country neighborhood demands real roads.

The care of roads is largely a community undertaking. One form that road activity has taken is that of road dragging. In many rural neighborhoods, road-dragging clubs have been formed, and the entire road mileage is dragged after each heavy rain. Even in the absence of hard-surfaced highways, this makes possible the all-the-year-round road.

**Other neighborhood movements.** The neighborhood fair, picnic, and pageant are among the best of community activities. First of all, they get the people together, get them to working together, talking together, and thinking together. The result is coöperation not only in one particular project, but in many others in which the neighborhood is interested. The country community needs to be cemented. The people of the farms need to be brought closer together, so that they will the better know and understand each other. It is the half acquaintance, like the half truth, that hurts. A lack of understanding may breed suspicion. A good motto that has been suggested is, "Get acquainted with the other fellow; you might like him." Getting acquainted, then, means a strengthening of the community and makes possible real team work.

**Fairs and other neighborhood activities.** A fair, if it be clean, high-class, and of educational value, is a strong incentive toward agricultural betterment and community upbuilding. The neighborhood fair does more than call attention to the resources of the community. It develops united work and leadership. One reason why more communities do not develop leaders is, that they have no work demanding leadership.

Many country towns and villages have joined with the local community or neighborhood in conducting local agricultural fairs, and in this work the people of the farm and of the town have been brought into closer relationship. Neighborhoods growing special crops frequently hold feature fairs or picnics. These may take the form of local fruit exhibits, grain shows, "melon days," or "strawberry days." Such activities not only draw the people together, but are valuable advertising for the leading product of the community. Much along the same line, but distinctly educational in character, is the farmer's institute or agricultural short course, open to every neighborhood of progressive farmers.

**Strength in coöperation.** (See Chapter 6.) There is need of coöperation among farmers, and it is the development of the neighborhood spirit that makes possible this joining together of forces. Many men working together can accomplish a task that would be impossible for one man. "In union there is strength." The truth brought out in the old story of the bundle of sticks has not changed.

One farmer alone cannot successfully combat insect pests. No one farmer can rid the neighborhood of chinch bugs. It is practically useless for one farmer to put off wheat sowing until danger of the Hessian fly is past, if his neighbor's wheat is sown early in the season. Working alone, one man cannot bring about better schools in a neighborhood. One man dragging the public highways cannot keep the roads of a community in good condition. One man cannot make a partnership fence good by keeping up his honest half, if his neighbor fails. Good, strong rural churches require the support of more than one man or one family. One man who wants and is willing to pay for his share in a telephone line, cannot bring such an improvement to the community. There must be joint work on the part of the neighborhood before the poles can be set and the wires strung; the value of the plant increases according to the number of people it reaches. This same principle holds good in

many other phases of farm life. Insect pests and fungous diseases of the orchard will never be done away with except by community work.

In many parts of the country wolves prove a serious hindrance in sheep raising. This is due largely to the fact that pastures and open fields are brush-grown, thus affording protection for the wolves. For one man to clear the brush thickets will avail but little, but where all the farmers in the community join in a general clean-up, the wolves can be driven out.

Hog cholera annually causes a loss amounting to millions of dollars. One farmer may strictly observe the law as to the disposal of carcasses of dead hogs, and may use the best of sanitary measures, but no one farmer alone can conquer hog cholera. There is need of community coöperation. If the neighbor over the fence allows his hogs that have died of cholera to remain where they died, instead of burning the carcasses, the entire neighborhood is exposed.

As a result of the neighborhood spirit, we have coöperation in labor. Nor is this new. In the olden times there were barn-raisings, woodchoppings and other forms of agricultural activity. Men now join forces in harvesting and threshing, in filling silos, in putting up ice, and in much other work. We have beef clubs, ice clubs, lamb clubs, and similar organizations. Few communities are without their farmer-owned telephone lines. The value of farmers' mutual insurance has long been demonstrated.

One modern form that coöperation is taking is the purchase of heavy machinery, or of machinery that is but comparatively little used on the average farm. Farmers of a neighborhood now join in the purchase of a tractor, a stone crusher for grinding raw limestone, or a lime spreader. Cowpea hullers, threshing machines, and hay balers are frequently community- or company-owned, especially in districts where farms are not large. Such purchases usually result in considerable saving by the farmers and indicate good business.

**City and country working together.** Good business methods add to the value of every country community and especially so as regards the relationship existing between the town and its near-by trade territory. The town that is surrounded by farmers who are barely making a living will have in it merchants who are doing little or no better. So the town becomes vitally interested in the kind of agriculture that is being carried on in the country. The farmer who makes no money has no money to spend. It is, then, to the interest of the town to aid in the cause of a better and more profitable agriculture. Every farm should be looked upon as a factory, for such it is. It is worth while for the town to interest itself in the output of these factories, and to aid in the profitable sale of the surplus product. Loss on any farm in the rural community represents, to some extent at least, a loss to the near-by trading point.

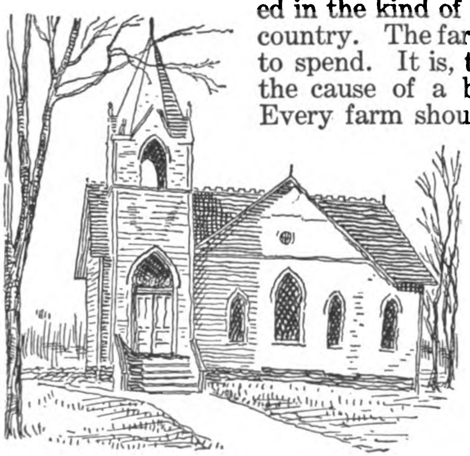


Fig. 91. Harmony Church (see p. 132), a center of religious activity around which a community has built a real neighborhood spirit of service and success.

So, the development of the rural community and the saving of the resources of the farm are questions of interest to city as well as to country. In making prosperous the farm, it is not enough that the farmer add to his bank account in the city. He must also, if the community is to continue prosper-

ous, add to that bank account which is represented in the increased fertility of his own farm. A neighborhood of soil robbers is not valuable as a business asset; commerce cannot long depend upon it. On the other hand, where progressive farmers join forces in business and in community upbuilding and betterment, the neighborhood becomes a source of great strength.

Through community or neighborhood effort, farmers are able to secure much that they want and need, and to make the neighborhood approximate what they would have it. Thus do they make it a real business asset.

## What One Neighborhood Did

*By* MRS. GROVER PEYTON, *of Paris, Mo., who has seen, from a real country woman's point of view, what one farm community has done, and what others can do.*

One spring a family from Illinois moved into our neighborhood. The neighbors were slow about going to see them; in fact they were always slow about going to see newcomers. During the summer a daughter of this family returned from school and, soon after meeting many of the people, saw the need of something to bring them together more often. Then, too, she said she wanted to study agriculture, so she thought out a plan. She invited all the neighbors to come to her home on a Saturday night in September, when, after an enjoyable gathering we talked it over and decided to make a regular Saturday night affair of it and to call it a class for the study of agriculture. Thus was born the North Side Agricultural Class of Paris, Monroe County, Missouri.

At first our meetings were very informal, our programs consisting mainly of talks by one member, an agricultural college graduate. Whenever he was absent the program was lacking, and we soon saw that we must be organized and give each member a part in the work; therefore, a better organization was perfected.

The meetings were held in our new neighbor's big, roomy kitchen. It was soon proved that there is no better way to make all feel at ease and enjoy the meetings more than by gathering in the kitchen.

We began the study of agricultural subjects as the season brought them. For instance, in the fall we had good programs and lengthy discussions on wheat sowing, including the preparation of the soil, the treating of the seed, and the best time to sow. Then came corn judging and talks on the selection and care of seed corn, which created a new interest in its better selection and care. This interest has borne results; those who formerly selected their seed corn in the spring from the shock or the crib, now select it from the field before the snows in the autumn and care for it in the proper way during the winter. This brought up another subject for study, namely, the testing of seed corn.

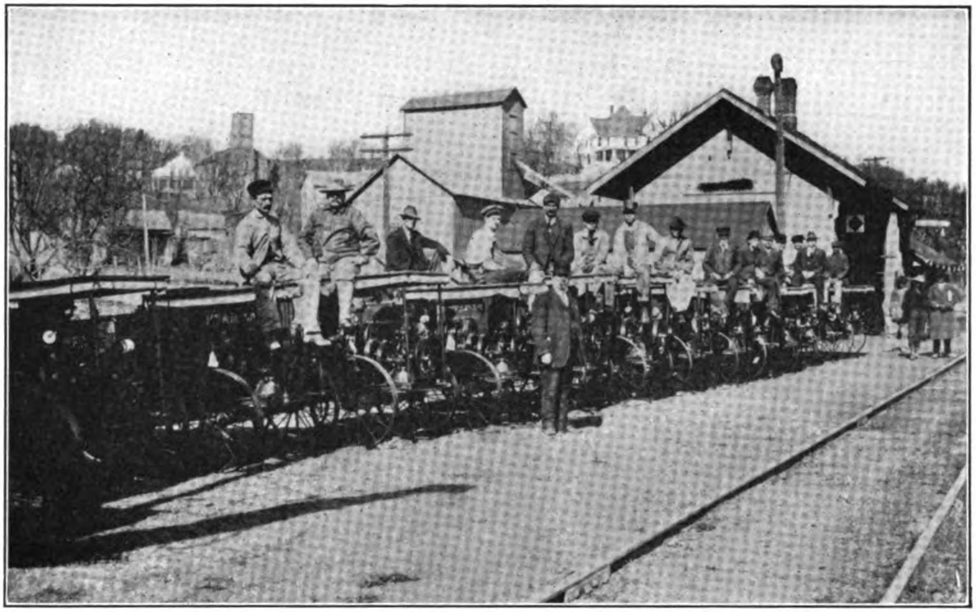
The winter months gave (and have continued to give) excellent opportunities for talks and the exchange of ideas regarding fertilizer and farm machinery; many of our evenings are spent in the discussion of livestock on the farm; and so the seasons bring new and ever-interesting ideas.

One year we decided, on a Saturday night, to make a display at our county fair on the following Tuesday. The time was short, but we made the display and won first premium and our success went a long way towards increasing the willingness and tendency of all the members to work in unison. Such work invariably creates a better feeling of friendship among its members.

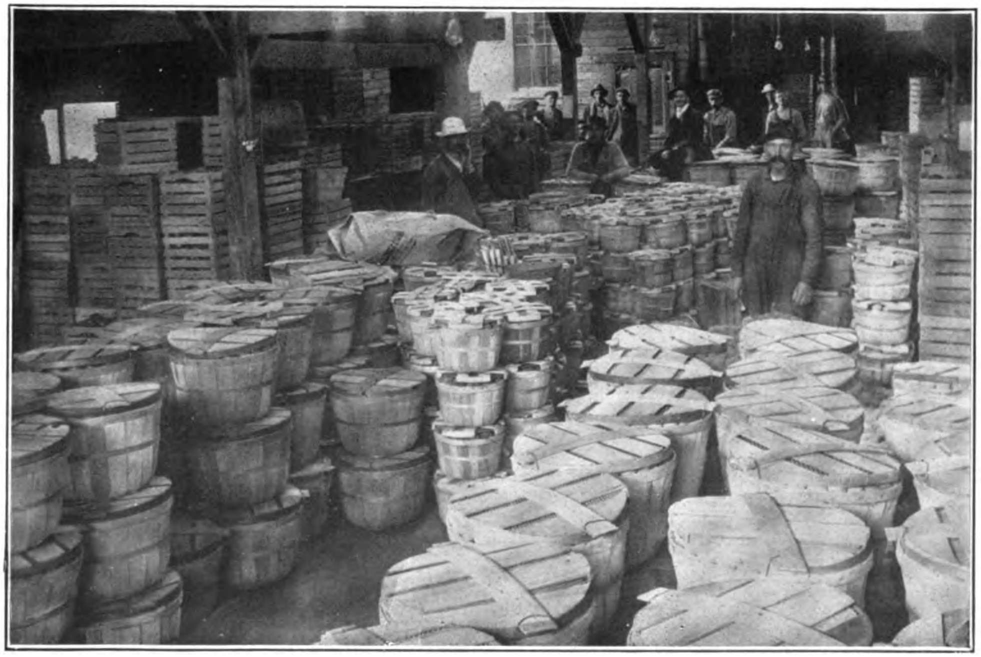
The townspeople have helped by coming to our meetings and otherwise manifesting an interest in our work. We have had some good talks from our town friends on Coöperation, Gardening, Marketing Farm Produce, and Good Roads. Our former superintendent of county schools also was a great help to us, meeting with us as often as possible and loaning us books. One of our members has a collection of bugs and worms and is well informed as to the life and habits of such pests. Another is an expert at caponizing; due partly to his work, our neighborhood is now a leader in the production of capons which command high prices.

When summer, with its extra outdoor work, comes, there is not much time to prepare programs, so our summer night meetings are more of a get-together-and-talk-it-over kind. The problems which have come up during the week are discussed, and often a neighbor has a valuable suggestion to offer by means of which the next week's work is made easier.

When, as a nation, we have these agricultural clubs, community clubs, or whatever you may name them, all over the country; when we have consolidated schools with plenty of room for these gatherings; and when we furnish amusement for our boys and girls as inviting as that in town;—then we will hold them close to the farms and the open country, and then we will have more progressive farmers.

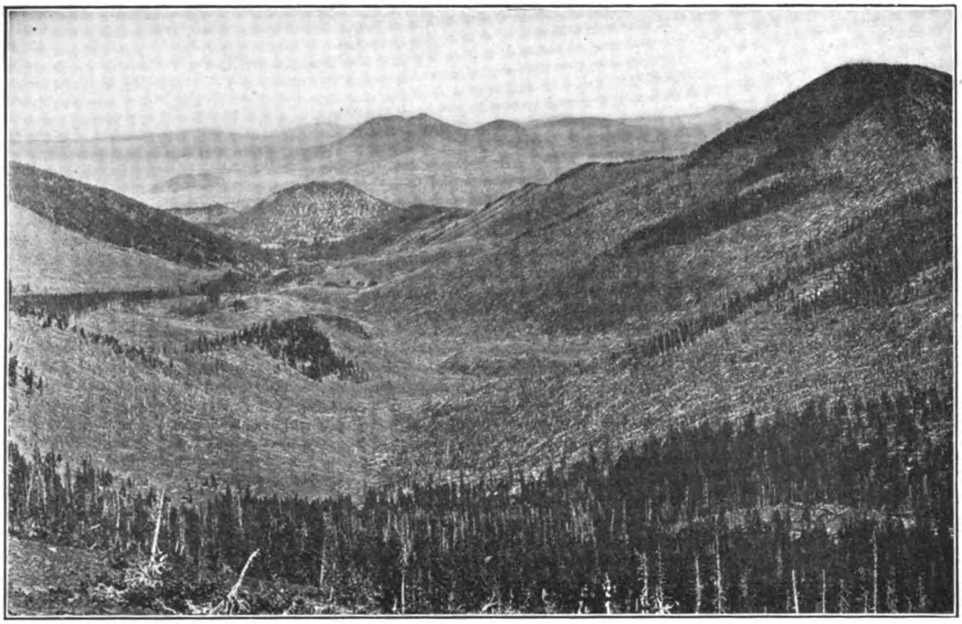


A purchase of thirty power sprayers made by a coöperative fruit growers' association that saved the farmers who got them more than $1,000. (U. S. Bureau of Markets)

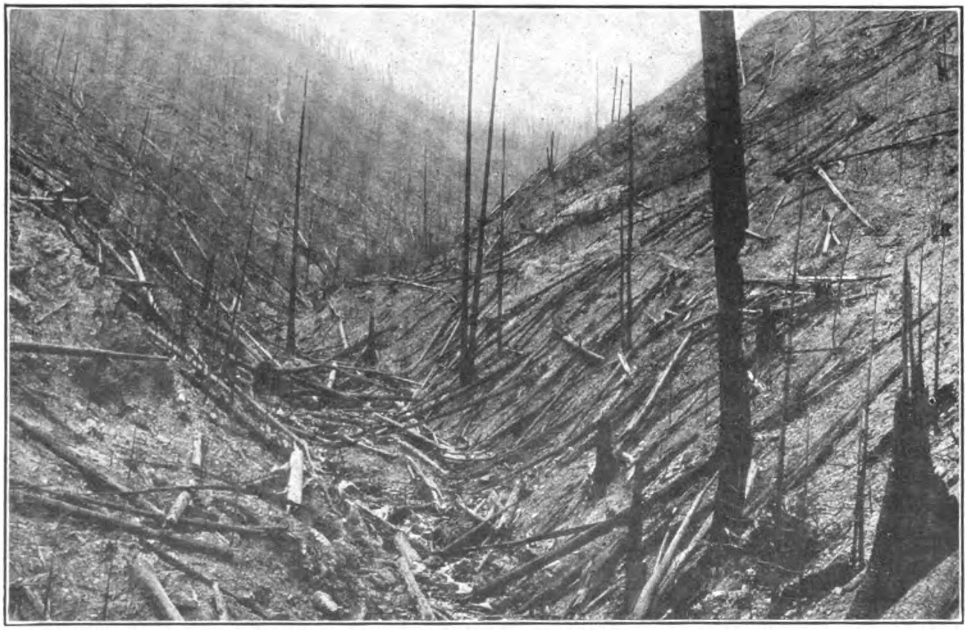


Shipping room in the $30,000 packing and storing plant of a Michigan coöperative fruit exchange that began when 25 farmer members subscribed $100 apiece. (American Coöperative Journal)

COÖPERATION IN FARMING IS GOOD WHEN APPLIED TO EITHER BUYING OR SELLING, BUT BETTER STILL WHEN DEVELOPED IN CONNECTION WITH BOTH



A forest devastated by fire. Our annual loss through such catastrophes is but one item in our national wastefulness—which is so largely unnecessary



A closer view. Not only is valuable timber destroyed, but also the power of the land to conserve water for future needs is greatly lessened

**One of the Chief Functions of Laws is to Protect Those Resources Which the People Themselves Fail to Look Out For.** (U. S. Forest Service)

# FARM KNOWLEDGE

## PART II

# The Farm Home, Family, and Community

NO farm is a complete success until it has been made not only a profitable business enterprise, but also a healthful, enjoyable place in which to live. Judging by the great numbers of boys and girls who every year give up farm home surroundings for city life, a good many farms must be in this respect at least, only partially successful.

There are many possible reasons for this; but all of them can probably be grouped under one or another of a relatively small number of conditions. In the first place, the boy or girl may simply lack the necessary characteristics of the farmer or farm woman; this is a circumstance that in most cases cannot be changed. Secondly, farm work as done on the farm in question may be uninteresting, uninviting, unprofitable; a remedy for this is the adaptation of modern, scientific methods such as have been discussed in the preceding pages and the earlier volumes of this work. Next the farm home may be lacking in comforts, conveniences, and such other factors as make possible a normal, healthy, productive existence; means for improving such a condition are discussed in Volume III as well as chapters that follow. Again, parents or the family as a whole may withhold that sympathetic interest and encouragement that is essential to the most efficient performance of a task, especially when the performer is a child. The failure to provide means for getting an education or to encourage the desire for it constitutes another great drawback. And, finally, there is that large field of outside interests, the life and opportunities of the environment, the neighborhood; normal men and women, no less than children, must have companionship in both their work and their recreation. Consequently the farm that is out of touch with its neighbors, or whose neighbors are incapable of stimulating mental growth and development, struggles along under an almost insufferable burden.

The next six chapters deal with the above mentioned factors as they exist, but more especially as they can and should be developed. They represent to a large degree the domain of the farm woman; but as maximum results can be obtained from the farming business only when all the family is concerned, interested and employed, so the farm home can reach its highest plane only when all who live within it coöperate both to create and to enjoy its blessings. —EDITOR.

# CHAPTER 10

# The Farm Home

WHEN, half a century ago, the pioneers crossed . . . 'the prairies, as of old the pilgrims crossed the sea,' the sole possessions of the settler were his prairie schooner, a team of horses and a dog. The first act of the homesteader was to build a hut, a sod house or a dugout. To-day the fruits of his toil and his pain are evident on every hand. Not the least conspicuous of these fruits are the homes that he and his sons have builded upon the wide prairie stretches. Gone are the huts, the sod houses and the dugouts. In their places are frequently found thoroughly modern houses, rivaling in luxury and comfort the houses of city dwellers."

This condition, as pictured in the Twentieth Report of the Kansas State Board of Agriculture, is typical not only of the great prairie regions, but of the country as a whole—wherever man has ventured in subduing the wilderness and establishing civilization. Thus among the most enduring and most striking of the farmer's achievements must be counted not only his farming but also his home building. Not every farm home, even to-day, presents such "thoroughly modern" conditions, such "luxury and comfort" as are quoted above. But it is not too much to say that every farmhouse can, and should, be a real, pleasure-giving, comfort-sharing home, one to be proud of, to have affection for, to want always to come back to. In such a home the inside and the outside bear equal responsibility for the total effect. Each can be made to attract or to repel, to charm the eye or to torment it, to soothe the spirit or to keep it constantly in an unexplainable state of unrest and distress. This chapter suggests how the desired ends—the creation of beauty and homelikeness—can be attained, simply and at low expense by any farmer, anywhere.—EDITOR.

## THE OUTSIDE OF THE FARMHOUSE

*By* RODMAN SCHAFF, *a practical New Hampshire farmer, whose farming means not only an attempt to make his business successful, but also a determination to make his farm a home, and his farm life a happy life. One way to bring about these results is to beautify the home surroundings with growing plants, trees and lawns. Mr. Schaff tells you, out of his own experience, how to do this effectively and at the same time simply. For directions as to the growing of ornamentals, see Vol. II, Chapter 30.*—EDITOR.

THERE is hardly anything that gives greater satisfaction than living in a house amid surroundings that are bright and cheerful. Nothing impresses the passer-by more favorably than a house which shows that the occupants love it enough to take care of it. All the members of every farmer's family owe it to themselves to make the spot they live in as beautiful as they can, especially since this may be done at small expense and with little trouble. A few well-placed shrubs, vines, trees, and flower beds, with a little well-kept lawn, not only add to the actual real estate value of a farm, but also make it a more beautiful and cheerful place in which to live

The very best way to start is to spend half a day clearing up around the outside of the house, getting rid of the trash and rubbish that is sure to accumulate where indifference, carelessness and lack of system abide. In fact, this first drive is usually half of the battle. The other half comes in planning and planting; and except for a few flowers which are started from seed each year, much of the work, once done, is done for all time, some for a generation or two, and the rest for a decade at least.

**Make the house the centre.** In planning to improve and beautify the home surroundings, always make the dwelling house the centre, including with it any lower, attached buildings such as woodsheds, dairies, and outbuildings of one sort or another. Big barns, wagon-sheds, etc., if close to the home buildings, should be cut off by planting a row of quick-growing trees, such as poplars. These need not be very close together since they look and grow better if 20 or 30 feet apart, than if half that distance. The idea is to make a reservation of the house and some of the land immediately around it. In such planting, curved lines for short distances are generally most effective, or straight lines ending in slight curves. In planting the house grounds, try to have the house look as if it had grown up out of the ground, which can be done in many ways, depending somewhat on the general style of the house itself.

**Use plants to soften the lines of the house.** Houses with porches along the front or across one end are made most attractive by planting vines which can be trained to run up the posts and along the edge of the roof, so that they will furnish shade in the summer. Select those that are hardy in your locality, or that need at most only slight protection in winter. Rambler roses grow quickly, afford good shade, and when in bloom produce an effect of beauty and brilliance that it is hard to duplicate or excel. A flowering vine is better than one without blossoms, because of the pleasing contrast between the bloom and the foliage, except in shady situations where the flowers are apt to be less brilliant than usual. In such places broad-leaved vines without flowers do better and produce fully as good an effect.

At each corner of the house, a small group of 2 or 3 shrubs that will grow about as high as the piazza roof, set 4 to 6 feet from the building will break the straight line, and in time will probably mask the corner entirely. Straight lines are seldom found in nature, and we are trying to make the house look as though it grew up out of the ground.

If the house is only about 20 feet from the ground to the ridge pole, lay out narrow flower beds, 2 to 2½ feet wide, along the front or side, having a sunny exposure. The higher the building, the wider the beds should be, but in any case, keep them shorter than the full length of that side of the house and far enough from it so that the plants at the back will be just outside the roof drip, unless there is a wide overhanging roof to protect them all. Put the tall-growing flowers at the back of the bed and those like sweet alyssum, pansies, and other bedding plants in the front. In selecting the kinds of flowers to use, try to arrange so that there will be some in bloom all summer, and enough over so that some can be picked to fill vases in the house. Masses or clumps of one color, or different shades of one color, are better than general mixtures of reds, blues, and yellows scattered here and there. If you select perennials (those which come year after year from the same roots, as iris, phlox, larkspur, etc.) or biennials (which live 2 years and often seed themselves, as foxglove, hollyhocks, clovers, etc.) and protect them properly in winter, the expense is not great to start with and but little care is required after they are started. Nothing decorates the outside of a house better than a few bright flowers.

Houses without piazzas can be treated in much the same way, except that the shrubs placed at the corners should be higher-growing. If these become so tall that most of the foliage is at the top, and a good deal of wood growth near the ground is left exposed, one or two lower-growing shrubs should be set in front, or others of the same kind may be used and cut back frequently to keep them broad and bushy and supply a mass of foliage from the ground up.

The same general plan can be carried out

FIG. 92. Vines and shrubbery have, as well as the ability to beautify, a definite, useful purpose: namely, the masking of ugly views. Note how one season's growth can hide a bare, unattractive fence and unsightly rubbish heaps

FIG. 93. The run-down, cluttered-up, untidy yard not only is unpleasant for beholders, but also has a discouraging, demoralizing effect on the family that inhabits it.

with the flower beds some distance from the house as has been suggested for those close to it, except that it is better to use higher-growing flowers, such as hollyhocks, at the back of them.

Vines on either side of a doorway trained around and over it, help to set it off and produce an effect of cosiness and hospitality.

In all selections of plants, shrubs, and flowers, keep the colors harmonious in relation to the color of your house. That is, do not use too many with red blossoms if the house is yellow, nor too many with yellow blossoms if the house is red. Violent contrasts should always be avoided; or at least the contrasting shades should be separated by white blooms which look well with any color and make an effective showing in any flower bed.

**The pergola.** Much can be added to the looks of a place with very little trouble and practically no expense, by building a simple pergola or arborway along one of the paths leading from the house to another building, the well, or some definite objective point. At the foot of each post, set a vine or two of a kind that in time will cover the structure. Flowering sorts are to be preferred to fruiting vines, such as grapes, which usually make unsightly litter, though it is better to raise grapes on the pergola than not at all.

**Trees.** A few well-placed, shapely trees are necessary about every house, but too many are about as bad as none at all, for two reasons. First, health depends largely on the presence of sunlight, and no trees that keep the sunshine from any part of the house the year round, or from any one room all day long at any time of the year, should be allowed to remain. Second, it is very difficult to have a well-grassed lawn if the trees are so numerous as really to shade it.

Fruit trees, if given plenty of room and kept free of branches within 6 or 8 feet of the ground, make very pretty spots of color in both spring and fall, and provide an attractive harbor for birds. As far as color effect goes, red varieties of apples, cherries, plums, etc., are to be preferred to yellow or green varieties.

Many unsightly sheds and outbuildings can be covered successfully with either grape vines, ornamental sorts or even dwarf fruit trees if you can afford and care to spend the time and give the attention required in training, pruning and tying them.

**The entrance.** If the house is reached by a long driveway from the road, a row of trees on either side of the drive is very desirable. In setting them out allow plenty of room for them to spread at the top but choose those kinds that are not apt to throw out wide spreading branches at the bottom. It is a good idea to start with one or two along the highway itself, thus forming an approach to your place. If the drive curves and is not lighted, a clump of white birches (if adapted to the locality) at each turn will prove valuable landmarks or "buoys" on dark nights.

Windbreaks, if desired, should be about 100 feet away from the buildings, and such trees should be used as make heavy growth near the ground. If evergreens, such as cedar, pines, spruce, hemlock, etc., can be successfully grown, they are effective not only as a windbreak, but also, in snowy countries, as welcome masses of colour during the winter, and as an excellent background for the house.

**The lawn.** No matter what is done to beautify the home surroundings, much of the effort will appear to poor advantage unless a well-kept lawn, even though small, is added. It gives the finishing touch and rounds out all the planting as nothing else can. As to size, make it only as large as can be well taken care of; this means running a lawnmower over it at least once a week in the summer and sometimes oftener. To look its best, a lawn should be kept close cut; a small one well cared for does much more for the looks of the place than a large one neglected.

If possible, it should extend around two sides of the house, preferably the southern exposures, and where low-branching trees will not shade out the grass. If trees are kept trimmed up, little trouble will be met with in getting the sod to grow well right up to the trunks; the use of the lawnmower will also be made easier. The best sod is one in which there is a large percentage of ordinary white clover. In making a new lawn, buy a reliable lawn-seed mixture and add an equal amount of white clover to it. Prepare the ground well, manuring, plowing or spading, leveling and raking carefully; then sow the seed thickly, rake lightly, roll, and water well unless the weather is rainy. Start the lawnmower when the grass is about 2 inches high, but don't cut too close or too often until it is well established. If cut often enough so that it is never more than an inch and a half high, it is best to leave the clippings as a mulch. Heavy applications, in the early spring, of chicken

manure and wood ashes at least a week apart will keep it bright and green all summer.

In making over a piece of old sod-land into a lawn, spread a few loads of good loam over it to fill up the hollows, level carefully, and seed and care for as just described.

**Paths.** Unless they can be kept free from weeds—which means quite a little work—dirt paths leading up to the doorways had better be put right into grass. Sometimes flat stones or flagstones are set in the grass to mark the paths and save the sod. If used, they should be laid perfectly level with the ground so as not to interfere with the lawnmower. Brick paths are attractive and durable, but weeds often spring up through them; concrete walks are lasting, relatively inexpensive, easily made with ordinary farm labor, and are most easily kept in good condition winter and summer. For the sake of dry feet and freedom from mud carried into the house, all approaches should be concreted, paved, or at least covered with boards during the muddy seasons.

Fences along the highway, if within 50 to 75 feet of the house, and especially if painted white, should have some vines running over them, or a row of low, flowering shrubs planted along them for a short distance beyond the house grounds on either side. Even the unattractive (though economical) woven-wire fence can be made sightly by planting a honeysuckle or small-flowered clematis at each post.

## THE INSIDE OF THE FARM HOME

*By* HELEN JOHNSON KEYES, *one of the editors of "The Farmer's Wife," and formerly editor of the Household Departments of "Farm and Fireside." A woman who, though not born on a farm, has found the source of her deepest interests and the field of her greatest endeavors among real farm conditions and practical farm people. She combines this sympathetic understanding and appreciation of farm needs and the farm point of view with a knowledge and a trained experience of how to recognize and bring about artistic results. She knows farm homes as they are; and she can describe them—as she does here—as they can and should be.*—EDITOR.

THE doorstep and entrance to the farmhouse cause us to form certain ideas as to the people who live there. Of course, some people are much better than their doorsteps. Some, too, are worse. In the main, though, we find that the spirit of the home greets us at the front door.

**Porch and vestibule.** A large front porch generally gives a pleasant welcome, but often it is not possible or best to have such a porch. In this case a pointed roof over the steps may provide protection from sun and storm, and two built-in benches with high backs, facing each other from either side, seem to invite the visitor to be seated till the door opens. The benches may have lids and serve as boxes in which to lay away overshoes and raincoats. In winter, the porch may be enclosed as a vestibule.

### The Hall.

The hall speaks the next word of welcome. Whether it is spread out and made into a sort of room, or whether it is only a passageway, we like better to have it light and bright. Often there is little free space for windows and, for the sake of privacy, we like to keep our door solid or to curtain its opening. It is wise to paint or paper the hall walls a bright color. Pumpkin-colored walls with thin white window curtains, white or oak-colored paint, and a good brown floor are good. Or the walls may be a creamy-tan and the curtains a real sunshine-yellow. In this case it is necessary to have a shiny material like China silk for the curtains, in order to get the feeling of light. Many men like red. Although dark shades of this color take up the light and leave nothing of it for us, there is a bright shade, known to the painter as Pompeian red, which gives back into the room all that it gets, with a little added for good measure. This would be too glaring for a hall which is used to sit in, but would do for a passage. Although white paint is prettier with this red than oak-color, the latter is all right. The window curtains should be thin and white, and the floors brown. Whatever color we choose for walls, let it be plain, or

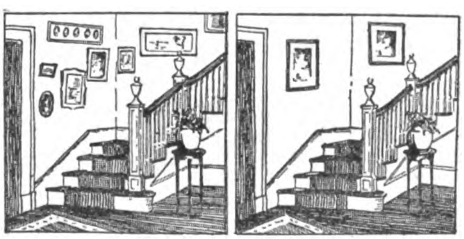


FIG. 94. A simple, attractive front hall showing how it can be spoilt (*left*) or made the most of (*right*) by an appropriate, artistic arrangement of pictures (see p. 147).

nearly so. If we like a design let it be indistinct and of the same color, though not of same shade as the background.

**Stairs.** Often the stairs are the first things to attract our attention. The stairway should be made up of steps that are broad rather than high. This means fewer backaches at the end of the day. Some may like a bright, well-padded stair carpet. Well may we forget for a moment the ever-present germ and remember what a protection this covering is both to the little feet and to the infirm ones which pass up and down. Frequently it is a necessary economy of heat to have the staircase closed. When this is so and the door is placed on the upper story, it has the advantage of cutting our falls short before they are begun instead of merely stopping us at the bottom of the stairway.

**Hall colors.** The color we choose for the hall will depend, of course, on the color we have, or plan to have, in the rooms which open out of it. It is not pleasant to pass from one color to another which does not "go" with it. It is true, however, that almost all colors will look well with one another if the right shades are used. The way to make red go with blue, for instance, is to mix some red in the blue, so that it becomes a red-blue. Then it "connects up" with the color with which you want to use it. And so on, with yellow and green, and green and violet, and all those primary colors we learned to name at school and which we see in rainbows. They are wonderful when they span our meadows, but they must be mixed in order to get along well in the house. Another way to bring about agreement between colors is to mix one of them with gray. Then it becomes what is called a neutral shade. Get the right shade by putting a little of the color of the one into the other or by graying one of them. We can then combine any colors we choose.

There is another fact to remember about colors: The greens, greys, blues, violets, and pinks are suited to sunny rooms; the reds, yellows, and golden-browns are for shady ones. The wheat-colored living room, therefore, needs the sun. If, on the other hand, it is a north room, get golden light into it with the colors autumn uses to make our countryside glorious when days shorten and the frosts nip. There they are, all the facts and all the suggestions for our rooms, written upon the ground and along the hillsides.

Fig. 95. A simple, roomy, hospitable living room furnished appropriately so as to give real comfort with a minimum of care and expense.

**Floors.** Here is another hint given us by nature: Outdoors we stand on dark brown earth; indoors let us stand on dark floors. A light-colored floor—unless the room is white and gold, good for a ballroom or a palace, not for a farmhouse—gives us a sense of flying, not standing. The floor should be the darkest tone in the room, the ceiling the lightest, and the walls a connecting tone. Speaking of ceilings, they are better calcimined than papered, but if paper is used, avoid a pattern. A papered ceiling may receive two coats of calcimine over the paper.

## The Living Room

In the farmhouse of our fancy 3 generations gather. There must be the easy chair and the couch for grandfather and grandmother, and these are loveliest when they are drawn near a fireplace. At a well-lighted table father reads his farm journal and mother's busy fingers ply the thread in a piece of fancy work. The young people have a big table all their own, where they can play games, read their books and bulletins, or make their shirtwaists. There is a piano, too, or a self-player of some kind ready with sweet music. Such a room furnishes itself; that is, it is furnished in the best possible way—with family life. With tables which do not totter, lamps which do not go out for lack of oil, and chairs which tempt to a little laziness, every evening may be made complete.

As a matter of fact, however, we sometimes grow critical of the places where we spend our happiest hours. Perhaps it is because we love them that we want them as nearly perfect as possible.

Some evening, for instance, it may occur to us that the ceiling is too low and we wonder what we can do about it. Now, the human eye is very easily tricked, and many defects in our houses may be remedied, so far as appearances go, with but little trouble. The ceiling which looks too low may be made to look higher by the use of a striped paper, running straight up to the ceiling without a border. On the other hand, if it is too high, it may be "brought down" by dividing the walls into three horizontal bands. The lowest stripe may be a broad one of paint, about a third the height of the room; the second stripe may be of a paper with an indistinct design; the third stripe is the ceiling itself carried down the wall to meet the paper. If a door is too high for its width, a shelf at the

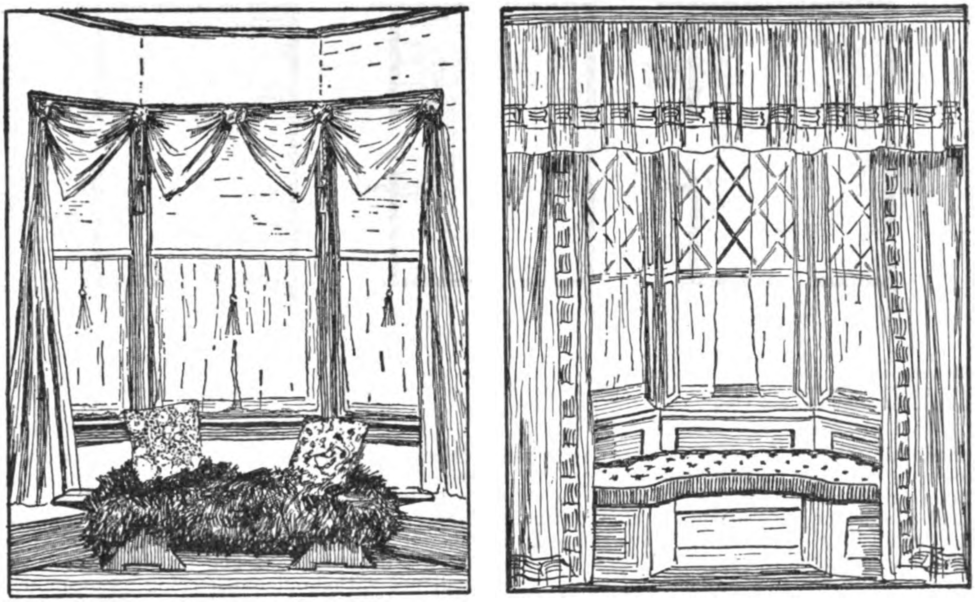


FIG. 96. A bay window seat showing poor taste (*left*) and good taste (*right*) in the choice and arrangement of draperies and fixtures

top will make it appear lower; and if it is too narrow it may be given breadth by placing flat against the wall on one side of it a couch or davenport and on the other a table of some size. Long, low book shelves will have the same effect. If there is a disagreeable feature about one part of the room which it is impossible to remedy or remove, attention may be drawn away from it if some very pretty or interesting article is placed opposite.

**Draperies.** A few draperies may give a room warmth and homelikeness, but there must be very few of them and none of the "stuffy" kind, such as woolens and plushes. Fringes, tassels, loopings, and festoonings should all be done away with. Chintz, cretonne, tapestry and denim do not take up dust so easily nor keep out so much light, so may be kept clean and cheerful. If the walls are plain, the draperies should have a design, but they must be plain where the walls are figured. Open spaces, clean paint, and well-dusted surfaces have great charm when left without drapery. This is especially true in a farmhouse where life is drawn directly from the bounties of earth, and not from the looms and shuttles of factories. No physician would hesitate to say: "Away with draperies," and the domestic-science teacher would certainly tell us to spare ourselves the labor of keeping them clean. Let us get the freedom of the fields, the big spaces, and the earthy, woodsy-looking things into our farm homes, and leave portières and hangings for the city house which has no such views as the country home affords.

Thin curtains at each window, however, are worth the trouble they cost by the way in which they trim and soften a room. The neatest way to hang them is from a rod which is run through a wide hem without a heading, and which rests on brackets almost at the top of the woodwork around the window. These curtains should fall straight down without tying, either to within half an inch of the floor or only to the bottom of the sash. The long curtains are more formal, but the short ones are often more becoming. Leave them drawn well aside from the window itself, so that the beauty of our acres will shine in. Lace is not a good material for farmhouse curtains. In its cheaper qualities it falls stiffly, softening neither the window-frames with its folds nor the light with its texture. If you can afford expensive curtains, pongee or China silk is most satisfactory. Among cheaper goods scrim is excellent, and cheese cloth falls in lovely folds.

**Shades.** Buy a good quality of roller shade. Nothing is more trying than shades which will not move or which rush up out of reach at a touch. The steel roller is better than the wooden one, and as it needs no tacks, it makes it easy to turn shades upside down when they are worn. The shade material should be adapted to hard wear. A shabby shade makes the whole room look shabby. In the south one often sees shades

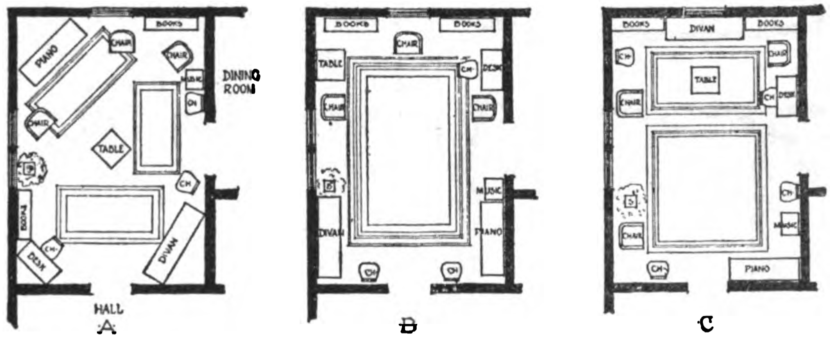



FIG. 97. Three possible ways to arrange the same furniture in a farmhouse living room. A tends somewhat to a cluttered-up effect because of the attempt to avoid straight lines; B approaches the other extreme; C practically provides two gathering centres in the one room. Personal preference and family habits must decide which style is the best to follow. (Cornell Reading Course.)

made of pretty chintz and the idea might well be used in other parts of the country. In a room with plain walls and no draperies they add a welcome decoration. If chintz is used for upholstery or cushions, it is well to have the shades match it.

**Rugs.** In our new standard of housekeeping many of us have come to prefer rugs to carpets. Old-fashioned rag rugs may be most attractive if the colors are well chosen and if woolen is not woven in with cotton. The fact that they may be washed in soap and water is a good recommendation. Many "art rugs" may be bought, but some of them wear poorly. There are on the market reliable Scotch ingrain rugs. They do not offer much variety of color and most of them are made with plain centres, but they cost but little, they wear well, and the dyes are lasting. An Indian rug is very rich and bright and well suited to a farmhouse. Wilton rugs are good in their designs and wear well, but the first cost is considerable. In regions where there is large game, fur rugs are very effective. Whatever we choose, let it be heavy enough to lie smoothly. If we are forced to use the slippery, wrinkly kinds, we may tack them lightly at the corners. Avoid designs that picture living things, roses and fat puppies. If we use a carpet we should not carry its edge to the wall but should leave a space of a foot or two so that a damp cloth may be used in cleaning the corners and cracks where dust gathers.

FIG. 98. A chair of severe, strong lines, well-made, good-looking and well suited to farmhouse needs.

**Floors.** We have said nothing about the timber for the floors themselves. Soft pine is the cheapest, quartered oak the best. Maple makes a light-colored floor which even oil does not darken. The floors of a busy farmhouse should be painted, oiled, or shellaced, not waxed or varnished, for the latter finishes will not withstand much going and coming. Either paint or oil may be kept bright by the use of a small amount of kerosene or milk in the cleaning water. Shellac is an excellent finish when home made or otherwise guaranteed pure. The yellow flake shellac may be bought at a druggist's and dissolved in wood or grain alcohol at the rate of 6 ounces to a pint. The shellac dissolves in about an hour. The mixture should then be strained through cheesecloth. In applying, work it with the grain of the wood and make the strokes long and slow. It has been estimated that in normal times the total cost of a soft pine floor laid and painted is 4 to 5 cents a square foot; that of a hard pine floor stained with 2 coats of shellac is 9 to 10 cents; and that of a quarter-sawed oak floor stained and filled with 3 coats of varnish, 19 to 20 cents. Straight oak with stain and 2 coats of varnish can be laid for 11 to 12 cents. In many cases the floor can be put down and well finished for less than it can be laid unfinished and receive a Brussels carpet or linoleum covering.

**Furniture.** There are farmhouses with attics where are stored heirlooms of what we call the Colonial period. Nothing better in furniture has been made and all these fine old things should be fixed up

FIG. 99. Although cheaper in materials, finish and appearance, and less serviceable, this type is often bought.

FIG. 100. Examples of simple, inexpensive yet varied and artistic pottery which is far more desirable and effective than useless bric-a-brac.

and worked over by the handy man or woman of the house.

The Mission style has become very popular. It is built on the principle of straight lines, so does not look well in a room with pieces of the curved-line, Colonial type. The only furniture which combines with it is large pieces of willow, of which the heavy, solid effect may be increased by brown or green paint, and which can be given a touch of color by means of bright cushions. One possible objection to Mission furniture is that it is apt to be too heavy. We like to move our chairs easily, even though they are solid enough to give us a feeling of safety when we sit in them. Willow furniture in a farmhouse brings outdoors in with it. It is durable yet light, may be painted any color to suit the room, and may be dressed with cushions. Chairs of solid, painted wood are always attractive. Morris chairs are homey and comfortable but costly. Sets and suites are no longer bought by the wise housewife.

**Ornaments.** Bric-a-brac harbors dirt and fails to make things look pretty. Flower vases should be merely holders for the bright blossoms and must attract little attention to themselves. If you have an open fireplace in the living room, put on the mantel above it a simple clock, if you have one, and one or two pottery jars in solid colors, without bold designs. The yellows, blues, and reds, copied from the potteries of ancient China, are usually good, even in cheap pieces. Pottery speaks of the earth and belongs in a farmhouse. Brass and copper are beautiful and should be used where their sunshiny faces will bring cheer. China and glass, except in qualities to please the millionaire, are generally poor in form, color, and ornament and merely litter a room. They become holders of burned matches and other little scraps which belong in the waste-basket. By all means let us have a good waste-basket, a durable, solid one which does not drop what has been put in it.

**Pictures.** Pictures require thought as to subject, framing, and hanging. We should never think of a picture as just something to put on our walls. Every picture should give us pleasure. There are pictures which please for an hour or so, but of which we grow tired if we look at them too long. In order to avoid this mistake, it is well to keep them near us for a time before going to the expense of framing. It is safer, too, to depend on the old painters, who have undergone the test of centuries and who are still loved and enjoyed. We can be pretty sure that we shall not tire of what they drew. Statues and great buildings are very fine in photographs, and their lines are so simple and bold that they stand out clearly from the wall in a companionable way. Useless wall-baskets, advertising calendars, or postcards should not be pinned up except in an office or a private room or bedroom the occupant of which knows that he or she likes them there.

**Framing pictures.** In framing pictures, the mat should be tinted to harmonize with the tone of the picture. In the case of a photograph this is either black, brown, or gray, although a gilt mat with a black frame is often very good. A gilt frame may also be used with a gilt mat. All mats should be narrow. The most attractive framing is often done without a mat, especially in the case of large pictures, when flat, square-cut frames set close to the photographs are very effective. Small pictures look well with a home-made "passe-partout" frame, that is, a strip of leather or strong paper glued like a binding to the edge of the glass and over the edge of a cardboard back which holds the photograph. Three large pictures decorate a room much better than a quantity of small ones. If the three subjects are similar—like three buildings, three statues, three madonnas, or three

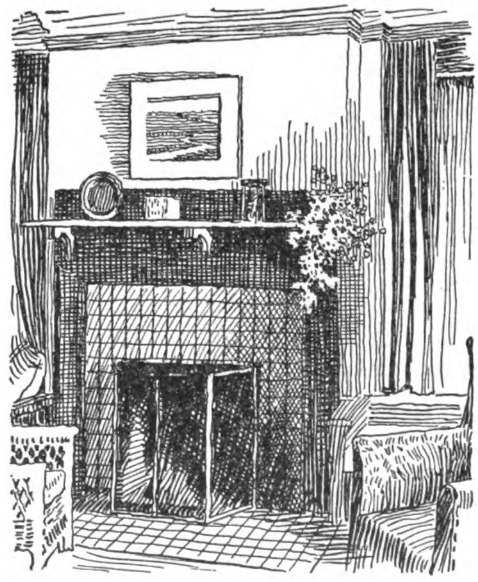


FIG. 101. A fireplace is more a thing of sentiment than of utility. It must, therefore, be attractive, appropriate to the house, and in every way a dispenser of comfort and good cheer.

FIG. 102. A fireplace and mantel in a room which is about everything it should not be. Note the "loud" carpet and wall paper, and the cheaply elaborate, gaudy bric-a-brac and furniture—ugly to look at and hard to keep clean.

Dutch farm scenes—they look well framed alike. If you have to use small pictures, group several together in one space instead of scattering them in a spotty fashion here and there.

**Hanging pictures.** In hanging pictures we may use: (1) a single wire which comes to a point over a picture-hook on a molding; (2) two wires, one going straight up from each side of the picture to two hooks on the molding; (3) a short wire hooked over a nail driven into the wall behind the picture. The latter method mars the wall, but if we are sure that we want the picture to hang always in that one place, no great harm is done and it is a gain not to have the ugly wire in view. If we use the molding, the double wire prevents the tipping of the picture after the lengths are accurately adjusted—but it is not always an easy matter to get the wires just the same length in the first place.

**Books.** Books in the country home should treat, very largely, of country things—of livestock and crops, of birds, flowers, grasses and insects. Of course, books of travel, history, and fiction, as well as the old standard works may have a place, but the farm interests should come first. Books add brightness to a room and, in a way, make it possible for us to know the owner. Many like books on open shelves. Glass doors protect them against dust, but if there are no doors, perhaps their use will be increased enough to protect them. In any case keep them in order, instead of allowing one to be on its side, another upside down, another pushed out of line, etc.

**The fireplace.** An open fireplace with wood logs, or with a coal grate, supplies cheer and beauty. There is nothing which will add more cosiness and enjoyment to a living room on winter evenings. A chimney faced with red bricks or large stones, according to the character of the region, is an ornament at every season.

**Lighting.** All of us would like to have electric lights because they are convenient, clean and bright. However, those who can not have them may take comfort in the fact that gas and coal-oil lamps afford softer light which may be better for the eyes. Whatever lighting we use, let us be sure that the rays fall on our work and over our left shoulder. We should not let the light come from both directions, nor should we face the burner. For this reason, side-lighting from brackets on the wall has great advantages over the central chandelier. Some movable lamps are needed. There may be one or two for tables with perhaps a tall piano lamp on the floor. Lamps are often ugly when it would be just as easy to have them pretty. A lamp which has a pottery bowl of solid color without decoration trims the table more than one of glass or nickleplate. China lamps decorated with flowers are not a good selection. The shades or globes on lamps and burners should be tinted to go well with the general color of the room. Green, ecru and rose-color are the prettiest. Any lighting which is said to be "just like daylight" is likely to be very trying unless well shaded; we do not sit down and read in strong sunlight.

## The Parlor

If we are to have a parlor at all, it should show the same common sense furnishings as the living room. Its coloring may be more dainty and its arrangement stiffer, if that seem appropriate, but there is every reason why the room should not be dismal. Here, as elsewhere, the chairs should be strong enough to sustain weight comfortably. It is well to avoid fancy tables with strangely twisted legs, bumps, knobs, and pockets that collect dust.

Let us keep the window shades half-way to the top. Cheerfulness is always better than gloom. Pictures should be well chosen. Upholstery and draperies, if used, are best if light in color and dust-shedding in texture.

**Why not a play room or office instead?** But, after all, why not turn the parlor into a playroom for the children? Then there will be no picking up of the living room to make it orderly for the evening. Or, the parlor may be changed into a library with books, papers, music and games for all the family.

Here, too, perhaps, may be the farmer's office where he can attend to his bookkeeping and correspondence at a comfortable desk, and see his business callers. However, where there are grown daughters in the family, it must not be forgotten that they will want some attractive place to entertain their friends. In some farmhouses the parlor and living room are really one room separated by sliding doors which may be closed as desired.

## The Dining Room

Whether it is wiser to combine dining room and kitchen or to keep them separate, must be decided by each family. The important thing is to decrease labor and increase comfort. The combination means fewer steps taken at meal times. On the other hand, the dining-room portion of the kitchen is harder to keep clean and orderly than is the separate room. Moreover, many housewives find added rest in the meals eaten out of sight of their workshops.

If separate rooms are wanted there should be between them a door swinging both ways. A table beside this door on the kitchen side and another near it on the dining room side will help in the service of meals. The dining table should be firm on its legs and such that it can be made larger when more room is needed. The chairs should match one another. Instead of buying a sideboard, cut a window between the dining room and kitchen at the right height for passing dishes back and forth. From its base run a broad shelf, set out half an inch from the wall so that no dust will collect along the back. This shelf may run the length of one wall or it may turn a corner, thus occupying a portion of two walls, according to the position of the window. On it keep the dishes which are in daily use. The idea may be made more complete by adding shelves below or above and by having closed cupboards at the base for occasional dishes and for left-overs which do not need the cold of cellar or ice-box. Set out the cupboard shelves half an inch from the wall to match the upper ones.

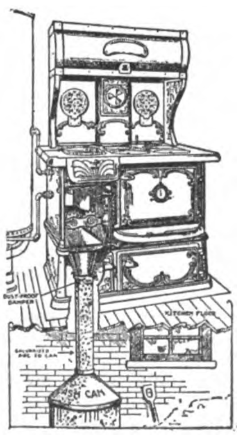


FIG. 103. An ash hopper connecting the range with a barrel in the cellar, saves work and helps keep the kitchen clean.

Where there are young children, or much hired help, or both, neither carpet nor rug should cover the floor. Painted, oiled or shellaced boards, or linoleum may be used and kept thoroughly clean. Oil-painted or flat-finished walls are better than paper on account of the ease with which they are wiped down with soap and water.

FIG. 104. The farm family has but little time to read. Its books and the surroundings amid which to read them should, therefore, be of the best. This is an enviable library corner in a real farmhouse.

Oil paints give a warmer and more lustrous surface, but the less expensive wall finishes are also satisfactory. When the plaster is left rough, the effect is better because it is less tiresome. The color should be chosen with the same thoughts which helped us to decide in regard to the living room. Plate-rails are not to be recommended. Dust gathers upon them and they are too high to be cleaned without special effort.

## The Kitchen

The secrets of a good kitchen are: (1) to group together in handy places utensils which are used at about the same time; (2) to have range, sink, and tables of convenient height; (3) to get rid of water and dust-collecting cracks; (4) to have good light; and (5) of first importance, plenty of running water.

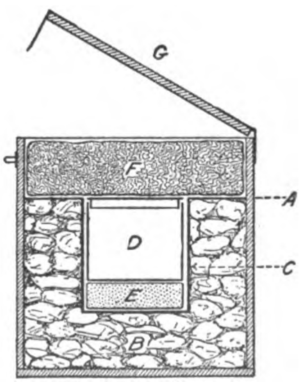



FIG. 105. Section of a homemade fireless cooker. A, outer wooden box; B, crumpled newspaper or other insulating material; C, metal container; D, cooking vessel with cover; E, soapstone; F, insulating cushion; G, wooden, hinged, tight-fitting cover with hasp.

Walls and floors. The walls should be

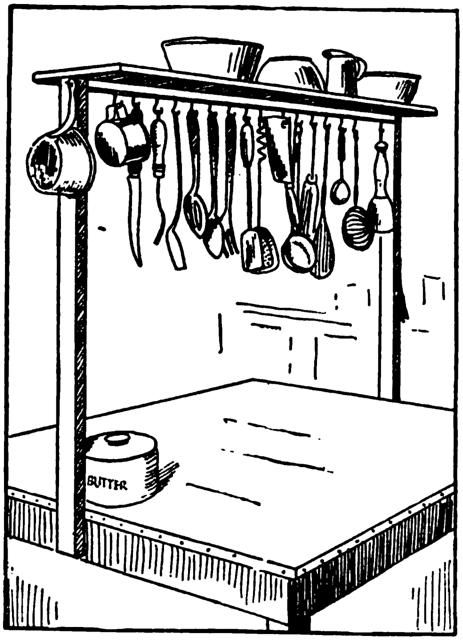



FIG. 106. Kitchen work table with device for holding cooking vessels and utensils, enabling it to be conveniently placed in the center of the kitchen.

painted a cheerful color. The pleasant pale shades of green, blue, gray, yellow, and pink do not suffer from washing, so that there is no excuse for using muddy, dark colors. The floor should have no carpet, but its boards, in order to be sanitary, should be tight and well-painted. If we use linoleum, the pattern ought to be bright and attractive. It should be laid in one width, and, instead of ending at the baseboard, should run up against the wall for a few inches over a rounded bar of wood. A three-cornered piece may be clipped out of the top at each corner of the room to get rid of the fullness. This is a sanitary covering and can be freely mopped without fear that water will trickle underneath it and form a dirty layer where germs will grow rapidly. Something pleasant to see from the windows is a help all day. If nature has not provided it, we can plant flowers within sight to cheer us for half of the year, and through the winter we can have window-boxes (Vol. II p. 426). Doors which permit a view into the living room or into other pleasant corners of the house, often stimulate us to fresh thoughts.

**The range** is almost the centre of the health and happiness of the family. If possible, let it be a good one, costing between $50 and $85, according to the amount and kind of cooking to be done. If we are in the natural-gas belt, we shall find the high ovens with glass doors worth paying for. They save many stoops, and burned fingers. On any kind of a range a thermometer attachment secures even the experienced cook against many half-failures. If the stove is too low, it may be raised on blocks. Then, there ought to be the fireless cooker—a homemade one if not possible to buy one.

**Cupboards** with shelves set half an inch from the wall serve for utensils seldom used. The heaviest kettles are placed low so as to save lifting. The utensils, spices, flavorings, tea, coffee and other things which we use constantly should be on hooks, racks, and open shelves above the working table near the window opening into the dining-room and on the left of the sink. The work table should be covered with oilcloth or zinc. Brass hooks set lengthwise in two wooden strips, which are as far apart widthwise as the length of the handle of a mixing spoon, make an excellent rack for tools which have no hanging holes. A good-sized lamp should be on a swinging wall-bracket at the left of this work table, with a similar one at the left of the sink. These shelves and racks are a homemade substitute for the kitchen cabinet which may be bought for from $15 to $30.

**Bins** for flours, cereals, sugar and grains, can be built against the wall opposite the range. An extra table with a good drawer is a convenience.

We have now disposed of the space along two and a half walls, or at least a portion of those walls. That leaves the space on the right of the range and along the wall at right angles to it free for the grouping of laundry utensils. There should be a shelf for irons, wax, bluing, starch, oxalic acid, and all the other necessaries and helps. There are ironing tables steady enough to rely on, which may be folded against the wall when not in use. Where the weekly washing has to be done in the kitchen, room must be left for tubs and wringer.

**Ventilation.** In every kitchen there should be opposite windows for cross-ventilation. If not, odors will creep into every corner of the house. One window should be kept open at the top, so that the foul air may escape; the other at the bottom, so that the good air will come in. When cooking is going on there should be an opening through which the heated upper air may escape.

**The milk room.** A separate milk room is a sanitary and convenient bit of building. It should have many windows, some of which are on the purifying south side. The cement floor should slant down at one end or towards the centre and connect with a drain leaving no cracks. Nothing should stand on the floor where it will be in the way of the washing process. Separator, butter-worker, and churn can be hung from the ceiling. A large tank for running water will keep

cold the milk and cream cans and the water-tight butter boxes.

**The cellar.** The cellar or basement should extend under the entire house, to keep out moisture and wind. Walls and floor should be of cement. Large windows placed opposite each other are necessary for the cross ventilation which ought to be provided day and night at all times except in the most severe weather.

It is not safe to store large quantities of vegetables in the cellar, as they will rot, but a supply may be stored in a room built for the purpose at one end of the cellar. Its tight partitions should be plastered on wire lathing. The ceiling should be treated in the same way. Half of the window should be darkened by dark green baize, and the other half of it fitted with a wooden, air-tight ventilating shaft which goes up outside, roof-high. Vegetables for storage here should be packed in barrels of sand.

If it is not possible to do this amount of building and repair work, we may look after the health of the family by providing good cross ventilation in our cellars, sanding the floors several inches deep, and whitewashing the walls with lime.

**The bathroom.** If we cannot have a complete bathroom all at once, let us build it gradually. A room near the kitchen can perhaps be set aside and furnished with a tub of enamelled iron, costing about $30. This may empty into a hopper filled with creosote preservative the contents flowing out through a tile drain. A tank for heating water may be placed above the tub, which it will fill with a faucet; or the hot water may be brought in buckets from the kitchen stove. A stove should keep the room warm during the cold season. Unless the place is comfortable and the arrangements convenient we are not likely to bathe as often as we should. When a complete water system with first-class plumbing can be afforded, there are great advantages in having the bathroom on the second floor, where it is more private.

### The Bedrooms

So far as is possible, each member of the household should have his or her own room.

FIG. 107. An outdoor sleeping room, protected against storms but freely open to the air, is one of the best of the modern developments in country house arrangement.

This arrangement makes for health and happiness. The habit of sleeping first in one bed and then in another and of having clothes strewn around in various rooms, destroys decency and neatness. Beds left unmade till night, and perhaps slept in again without making, start boys and girls along the paths of slovenliness. Children should be trained to open their beds wide, to throw the covers back, when they go to breakfast.

The habit of sleeping out of doors or on porches in all but the most severe weather is a good one. Of course, each sleeping room must have its bed for stormy nights and illness. These should be placed, if possible, out of sight of the door when it is opened. Place the bureau where a good light from a window by day and from an artificial light after dark falls upon the mirror. The washstand should be furnished with a white toilet set or else with one which is open stock, that is, whose pieces can be replaced at any time without varying the pattern. None of us likes bowls and pitchers, mugs and soap dishes which do not match. A screen placed before the washstand is a convenient bit of furnishing. It can be made at home of two wooden frames hinged together in two places and braced through the middle by bars of wood. When burlap is nailed on such a frame with brass-headed tacks, the appearance is excellent. One or two washable rugs, two comfortable chairs and a table are all the other furniture needed.

Simplicity should be the watchword in furnishing our farmhouses—simplicity and things in keeping with the lives we lead. Simplicity does not mean that we do not care for beauty or that we are satisfied with ugly things. On the contrary, without careful planning we shall not have good homes, and without good homes we cannot send efficient young people out into the world. But we should find our ideas, not in city fabrics and customs, but in the materials and habits of our own communities. Thus our farm homes must show their wood and stone, must have light and space, color and breadth. Their arrangement must be suitable to the hard labor which keeps them up, but there must be play corners, too, so that our Jacks and Jills shall not grow up as dull boys and girls.

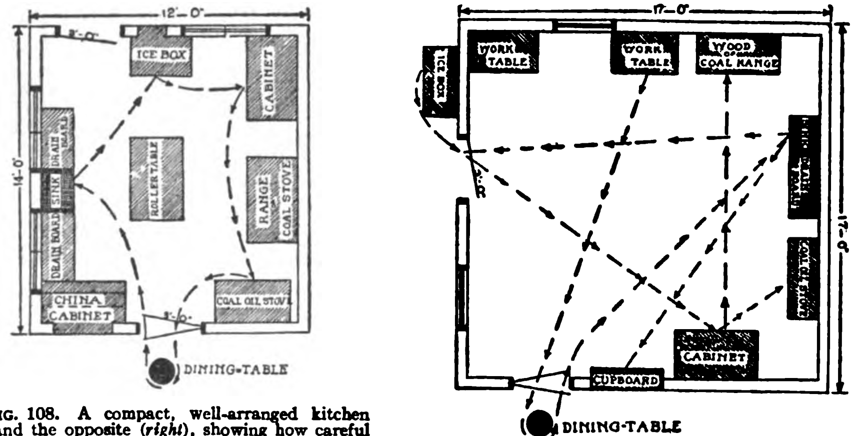



FIG. 108. A compact, well-arranged kitchen (*left*) and the opposite (*right*), showing how careful planning reduces the steps required in preparing and serving meals. A large kitchen is not necessarily a poor one, but a poorly arranged one of whatever size is a constant trial.

## Practical Suggestions for Home Planning

*By* BAB BELL *(see p. 181), with suggestions contributed by* MRS. H. A. JEWETT, *of Missouri, a farm woman who has studied her housekeeping problems and worked out ways of solving them.*

DURING the last few years, the farm home has been the subject of much discussion. Many people seem to think that the farm home can not and should not be as beautiful or as expensive as the city home. Often we hear the remark, "But that house is too expensive for the country," or "Those plans can not be used in the country; such a house would cost too much." Is it not true that modern homes cost money, whether they are built in the city or in the country? Are not country people, as much as city people, entitled to beautiful and modern homes? Should conveniences, such as light, heat, and water, be classed as luxuries, when in reality they are necessities? Anything which brings more comfort, better health and greater happiness should be classed as a necessity, not as a luxury. It is very hard for many country people to believe that light, heat and water systems can be installed in the country as successfully as in the city. One reason for this is that it is perhaps more difficult to find experienced plumbers in the country. Yet if these problems are given painstaking thought and study by those planning to build the home, and if careful supervision is exercised, satisfactory work should follow.

### What One Woman Did

Mrs. H. A. Jewett, a Missouri farm woman who lives in a conveniently arranged house which she herself planned, says, "The first thing to be considered in the building of a farmhouse is the saving of steps. Next to labor-saving machinery, is labor-saving planning. Above all, the farmhouse should be livable, for it is to a very large extent the farm woman's world. On the farm, if we grow lonesome, we cannot run down the street for a minute to greet a neighbor. So in the house and out of doors, we must find rest and pleasure. Let there, then, be plenty of windows—big windows and set low down—so that the tired farm woman, resting for a little while in her favorite low chair, can still catch sight of the pastures, hills and valleys with their flocks and herds. Always, in the planning of the house, pro-

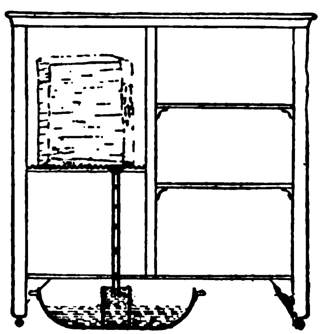


FIG. 109. Section of icebox showing water trap to prevent the entrance of warm air and the waste of the ice. If the pan can overflow into a drain, saving the trouble of emptying it, so much the better.

vision should be made for at least one window looking out upon the most beautiful view that the farm affords.

"Inside, the house should be attractive, but no room should be too good to use. The living room, with a cheerful fireplace, and the dining room—the two common meeting places of the farm family—should be as inviting as they can be made. Bedrooms should be so arranged as to provide for plenty of light and air. For the farmer to spend his days in the open will do little in the way of insuring good health if at night he sleeps in a small, stuffy room into which the sun never shines. Of course, every bedroom should have a big closet. On the farm, the men folks have to have many kinds of clothes, including overalls, work shirts and heavy shoes, and they need room to put all these away—to sometimes get them out of sight.

"No farmhouse is complete without an attic—reached by means of real stairs not a ladder or a narrow winding stairway. It should be well lighted. On the farm, there are many uses in addition to the ordinary ones, to which an attic may be put Here, in the fall of the year, the man of the house stores his seed corn where it dries out and where it is safe from rats and mice. Here, too, the nuts are spread on the floor, while from the rafters hang peppers and, perhaps, bags of dried fruit."

The ideal home should be planned to meet the needs of the individual family for which it

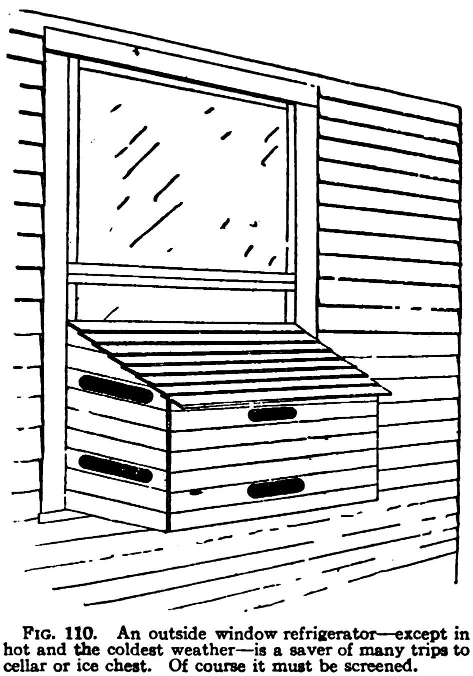


FIG. 110. An outside window refrigerator—except in hot and the coldest weather—is a saver of many trips to cellar or ice chest. Of course it must be screened.

FIG. 111. Most tables and sinks are not the right height for their users who are caused unnecessary effort, discomfort and actual physical injury by constant stooping. Note the effect of the added three inches.

is intended. It should be convenient, economical, and beautiful.

**The kitchen.** The kitchen is perhaps the most important room in the house, yet it is the one most often neglected. The average homemaker gives little or no attention to the kitchen until it is too late. After she has been keeping house for a year or so, she realizes how important it is that this room, of all others, should be well planned. Much of the kitchen work which seems to be drudgery is really due to inconvenient and gloomy surroundings. The convenient arrangement of the kitchen is more important than its size. It is well for the housewife to consider the arrangement of her kitchen equipment from the standpoint of convenience, and to decide whether or not a rearrangement would save her time and steps.

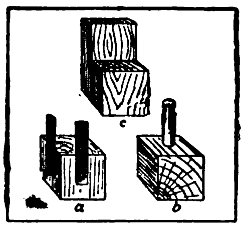



FIG. 112. Three ways to make a table the right height. *a* and *c* nail or screw to the legs; *b* is inserted in a hole bored therein.

Few kitchens are so perfect that there is no room for improvement, and no kitchen is so hopeless that it cannot be made more convenient by careful planning. Some kitchens need a wholesale changing of doors and windows for better light and ventilation; others need only a slight rearrangement of table, sink and stove to make a better working center.

Note the plans of two types of kitchens in Figure 108. That of the smaller, at the left, shows how steps are saved by carefully arranging the equipment. Important features are the sink and china-closet close to the dining room door, and the refrigerator within easy reaching distance of the cabinet, where the greater part of the meal will be prepared. The roller table forms a connecting link between the stove and the sink. If desired, a small service table may take the place of the roller table, and will be useful both in setting and in clearing the dining table.

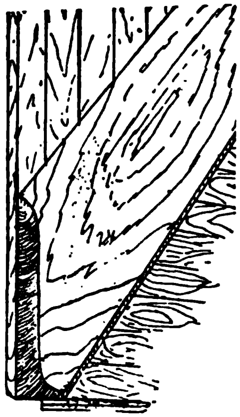


Fig. 113. A desirable, non-dust-catching type of base- or mop-board.

The sink is so placed as to get ample light from high windows. There is a drain board on each side and under this are built convenient cupboards or drawers. The china-closet is placed on the right of the sink, because of the northwest exposure of the kitchen, but with a northeast exposure, the closet would occupy its natural place on the left. Many women hesitate to place the refrigerator in the kitchen for fear that it will require so much more ice. A well-insulated refrigerator should keep ice with no reference to outside temperature if the door is not opened too frequently.

Mrs. Jewett, quoted above, says on this subject, "In planning our new home it so happened that getting food to the ice box and from the ice box to the table with the fewest steps was the first thing of which I thought. This may have been due to the fact that in the old house the dining table and the ice box were a long way apart. In our present home the ice box is in the pantry, which has direct connection with both kitchen and dining room, while an outside door opening on a concrete porch makes it easy for the men when the box is to be filled with ice. A dumbwaiter between dining room and pantry does away with any carrying of food around through the kitchen. In winter, too, when ice is not used, the pantry is kept cool by means of an outside window which is regulated at will. Another feature of the pantry, which, of course, is screened, is a screened-in shelf-rack in addition. Do the best we can on the farm, flies will sometimes get into the house. When the ice box is being filled, is apt to be one of these times. It may also be the housewife's busy day, when she has not time to 'shoo' flies. Then it is that the extra screened-in quarter in which are placed warm bread, pies or cakes, and other food not ready to go into the ice box, comes handy."

Sink, table and stoves should be high enough (averaging 32 inches) to eliminate stooping and prevent resulting tired backs.

Fig. 115. A built-in, white-enameled kitchen cabinet. Note excellent lighting, stool; and glass doors which keep everything clean but always in sight.

The plan of the larger kitchen (Fig. 108)—which is not necessarily bad because it is large—shows only too clearly how much time and how many steps are wasted in a poorly arranged room. Of the farm kitchen Mrs. Jewett says, "It needs to be a sort of adjustable room, small enough to save steps on ordinary days, yet big enough to serve on the 'red letter days' of the farm, when, with threshing or silo filling, there may be 15 or 20 men to cook for. We met this need by having the kitchen rather long and narrow, with range and other things in daily use in the end nearest the doors to dining room and pantry. In this way everything is just as conveniently in reach as would be the case in a much smaller kitchen, while on the big days, more of the work is done in the end of the room near the outer door opening on to a big concrete porch. This spare room in the kitchen we also find valuable when we care to iron there rather than in the basement, or when canning or doing any other work requiring additional room."

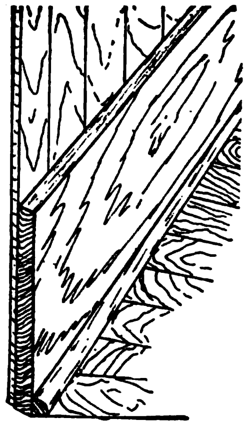
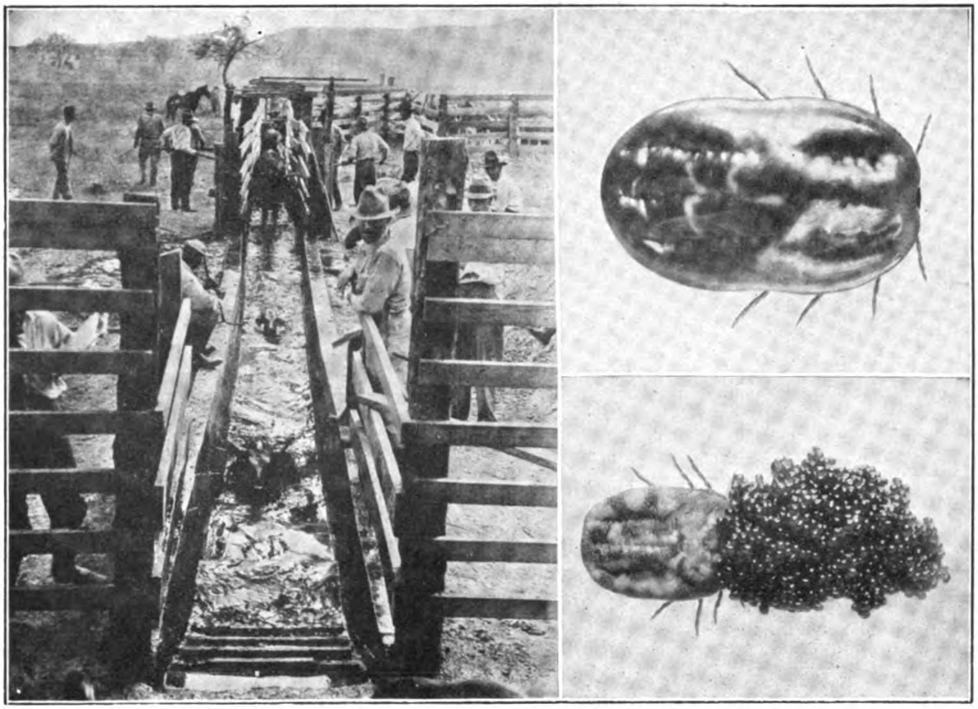


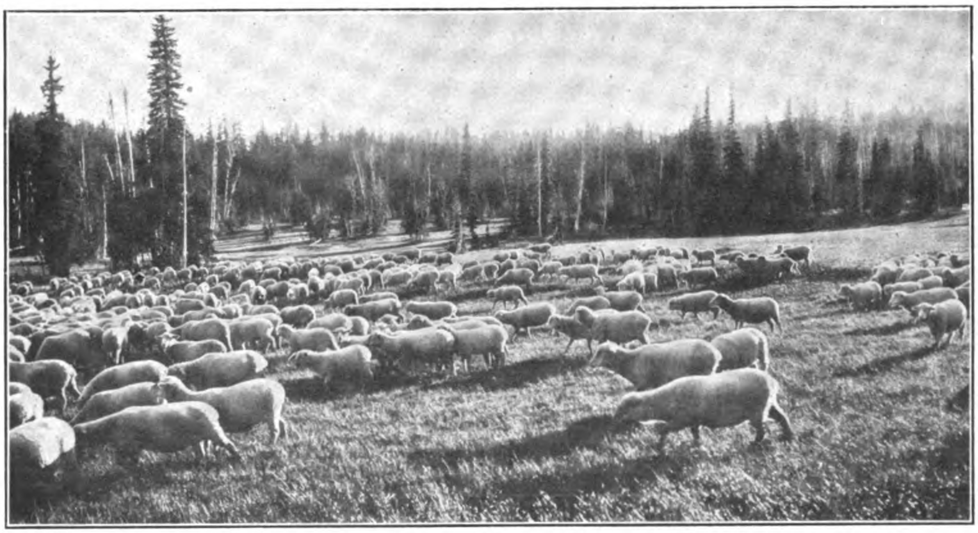
Fig. 114. The usual type of base-board that quickly collects dust and is bothersome to clean.

The stove is always a necessary investment. The steel range is the ideal stove where wood or coal is used. Its price varies from \$45 to \$85. Ordinary cook stoves cost from \$10 to \$35, but are poor substitutes for ranges, many of which have high ovens which save backaches. A range should be provided with a hood or canopy to carry off odors of cooking.

In the last few years kitchen cabinets have become quite common. They are a great aid in large, poorly arranged kitchens, since they keep most of the working materials at hand in one place. There are many good cabinets on the market, at prices ranging from \$10 to \$45. Arrangements should also be made for a pantry window-box in which food can be kept cold during many months of the year without the use of ice. It should be well made and painted the same color as the house.

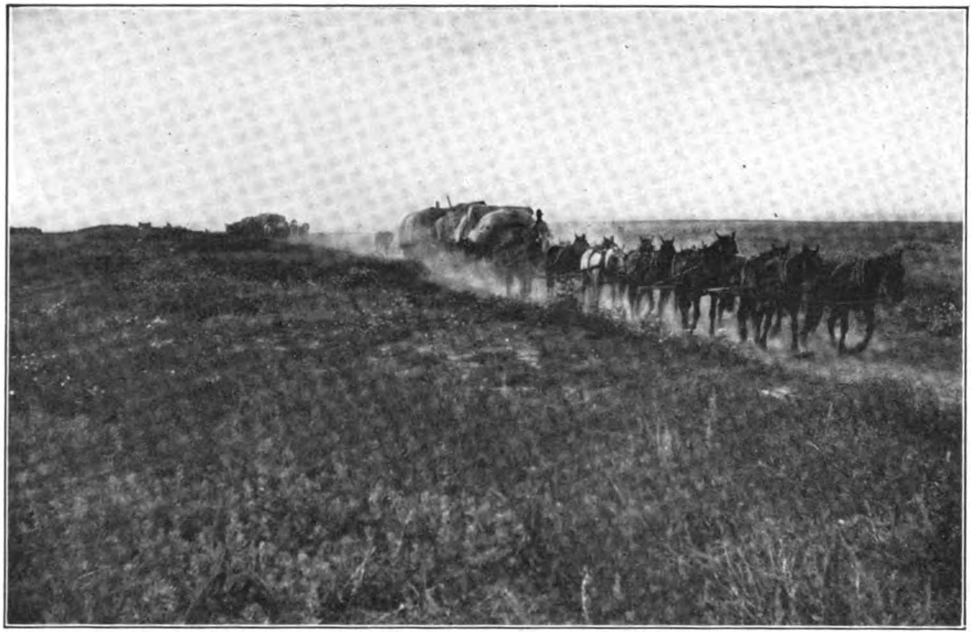


Farmers have been saved millions of dollars by being taught to keep their cattle free from the Texas fever tick. *At left*, a dipping vat for this purpose; *at right* (enlarged) an adult female tick engorged ready for laying, and (*below*) laying eggs. (U. S. Bureau of Animal Industry)

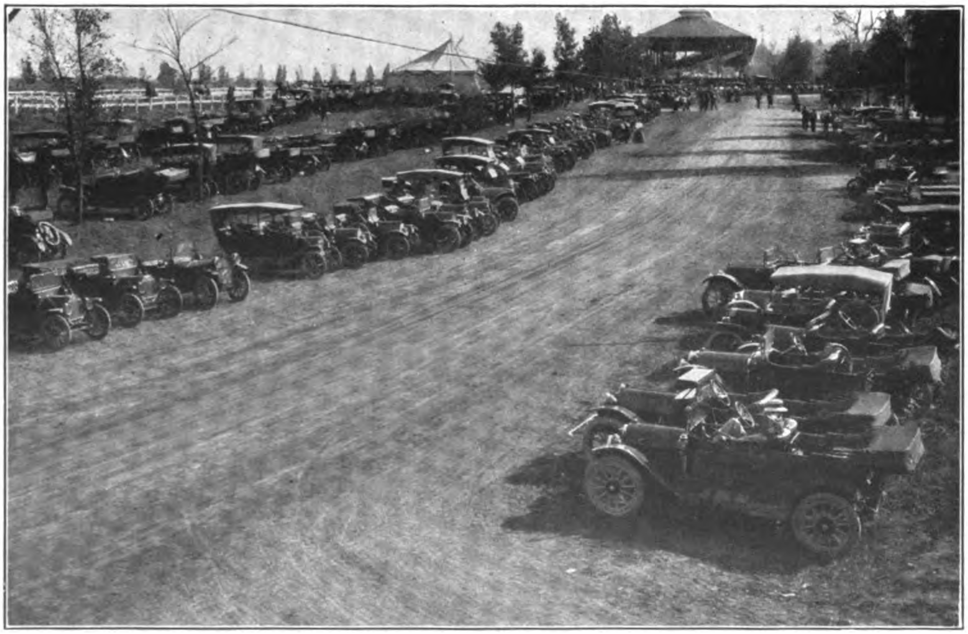


The National forests, controlled and maintained by the Government, furnish pasturage for about twenty-five per cent of all the sheep in the western range country. (U. S. Forest Service)

**THE FARMER HAS NO GREATER FRIEND THAN THE DEPARTMENT OF AGRICULTURE WITH ITS MYRIAD ACTIVITIES AND AGENCIES OF SERVICE**



How the farmer traveled when he began the conquest of the virgin soils of the New World—



And how he travels now that he has learned to take and use their riches without robbing them of their fertility

THE FARMER'S AUTOMOBILE IS A SIGN, NOT OF EXTRAVAGANCE, BUT OF THE WISE USE OF MODERN MEANS FOR INCREASING HIS EFFICIENCY BOTH IN WORK AND IN PLAY

## CHAPTER 11

# The Farm Family

*By* MRS. HELEN JOHNSON KEYES, RUTH M. BOYLE and MR. W. L. NELSON (*see Chapter 9*). *Mrs. Keyes' interests and efforts have long centered around the broader, fuller development of the farm home—meaning, not only the house and its environment, but also the human beings who live in it. The discussion of this subject, like the solution of many of its problems, as she points out, requires mutual sympathy and understanding. For her part, Mrs. Keyes is well supplied with both.* MISS BOYLE, *who contributes the discussion on hired help in the home, was born on a Western ranch and has lived the greater part of her life in the Far West where she has gained a practical knowledge of the farm woman's difficulties as well as her opportunities. She taught in a Montana rural school for 2 years, graduated from the University of Wisconsin, having specialized in journalism and rural sociology, and shortly afterwards became household editor of "Farm and Fireside."* MR. NELSON *writes, with intimate knowledge, on some phases of the hired man problem.*—EDITOR.

FAMILY life is the result of the long period during which the human child is dependent on his parents. Birds and animals quickly learn to take care of themselves, and, for this reason, the tie between them and their parents snaps. Off they go and, in most cases, the parents separate also. Thus the world in which these lower forms of life live is a world of separate individuals, not only independent of one another most of the time, but frequently unfriendly, each fighting against the creatures around him.

Human children, however, can not get along without the mother's care and the father's support. Brothers and sisters do their part, also, in the family circle. Sometimes the grandfather and grandmother who are in close sympathy with the men and women who are still their "children," unite the last years of their lives to the younger generations and become workers in the home-hive. Thus we have a large, loving group all depending on one another, all serving one another.

How has this group become possible? Through working together. The more we do in the right way for the members of our family, the more we love them. The more they do for us in the right way, the more they love us.

There must, however, be wisdom in the doing. Our purpose should be to add to the strength, the self-reliance and the self-respect of those whom we serve. To remove all sense of responsibility and influence from elderly people is a mistake. Grandfather should be more than a chore boy, and grandmother more than a nurse. To give them no other work makes them unhappy and ashamed and hastens old age. Give them a chance to put to use the knowledge and skill that are theirs. Let them serve the home, for in so doing they will be happier.

So, too, we must not keep children dependent longer than is necessary. We should show them how to be self-helpful. Let us serve them as teachers, but not as slaves. On the other hand, we do a bitter wrong when we demand from the young child harder or more perfect work, or longer hours of it, than are healthful at his or her age. Our young people must serve us not as slaves, but freely as true and loving partners.

## Coöperation in Family Life

It is easy to give the feeling and spirit of partnership even when hands are too old or too little for service. At least we can ask, "Would you rather have me put up plum or apricot jelly?" or "Which do you think would be prettier to plant, pansies or petunias?" Thus home becomes a network of sympathies, of mutual interests, of labors shared in spirit even when hands are feeble or untrained.

Unless husband and wife are partners, home is not all that it should be. Without true partnership there is a waste of money, time, and strength. Partnership is impossible unless knowledge of the household finances is shared by all grown-up members of the family. Each should have the management of a just percentage of the income—not as a gift nor as an allowance, but as his or her share of the business. The farmer could not run his farm without the women at home who manufacture wholesome food and clothing out of the crops and dollars he contributes. As junior members of the farm-and-home business, the children earn their shares and dividends.

The division of the budget into separate funds is often helpful, certain amounts being put aside each month for food, clothing, health-precautions, repairs, charities, "higher things" (such as magazines, papers, books, vacations, and parties) and investments. Such funds greatly increase the interest we feel in managing money, and make us more saving and give a good balance to family life. For the older children keeping these accounts is valuable training in arithmetic and neatness.

Homes exist partly for the sake of mutual labor, for the sake of honestly making money. They exist also for the sake of mutual pleasures and amusements. For both of these aims, coöperation is necessary. Time for pleasures and amusements can be found only in the well-adjusted household, where each member has his or her tasks, so arranged as to fit well into other people's tasks.

FIG. 116. "Human children, however, can not get along without the mother's care and the father's support"

## Systematic Management in Family Life

Time and strength can be saved by system in our movements, by the order in which we take up our tasks. Not all women can afford to have labor-saving machines, but all women can have an orderly way of doing their work. They can have labor-saving habits. Perhaps this sounds like poor comfort, but it must be remembered that machines have to be operated and kept in working condition by human hands. So unless the housekeeper knows how to do her work without unnecessary movements, confusion, and interruptions, all the time-saving machines on the market will not give her leisure and strength. On the other hand, a wise, orderly system, with only fair tools, may produce this leisure and save this strength.

In the year 1910, a new system of labor was introduced into some of the largest of our huge industries, such, for instance, as the Bethlehem Steel Works. A man named Frederick W. Taylor studied the way in which a gang of men picked up and loaded pig iron. As a result of his study he learned that a great deal of the strength of the men was wasted by the way in which the "pigs" were placed. They were constantly stooping and lifting when it was not necessary. The loading-vehicle was also awkwardly placed in relation to the men. By making a number of changes along these lines, and by having regular rest periods for the laborers, Mr. Taylor trained them to load 47 long tons of pig iron daily instead of 12½ long tons and with less fatigue. Their wages were increased accordingly. A man named Gilbreth did something of the same sort for bricklayers, finding that they had been making 18 motions in laying a brick, whereas 5 were enough.

This same idea has been put into housework by Mrs. Christine Frederick, an authority on home economics. Of course, we must admit that a home can not be run exactly like a factory and that we do not want it to be. A woman is bound to have many interruptions, so that her "system" will not run like that of factory employees. Nevertheless, there are ways open to most women whereby they can save about 20 per cent of their time and strength without buying anything.

To get this result, study each task and, if there are in your family people ready and able to help you, study them and find out which task each is best able to perform. Divide up the work according to what the members of the family can do best, and let each do his or her share regularly day by day

and week by week. Then watch the way in which you go about your work, ask your helpers to do the same with theirs, and see how many improvements can be made.

**Labor-saving habits.** Here are a few suggestions for labor-saving habits: When putting clothes to soak, soak the starched pieces separately and keep them separate through the processes of washing and ironing. This saves lifting and examining pieces. In hanging them out, push the clothes basket on a cart or barrow and attach a bag of clothes-pins to the line, to be pushed along as needed. In ironing, place the basket on a chair. All these things save stooping and retracing of steps.

In cleaning, first sweep all the rooms, then wipe all the floors, then dust. This saves many trips to pantries for the purpose of putting away certain tools and getting out others. Windows should be left to be done together another day.

In cooking, collect all materials before starting to make anything. If the worker will try to picture the lines on the floor which her steps would make as she comes and goes about her work, she will see that many of these criscrossing paths are unnecessary. She will then make one path do where there were three before. So far as possible, we should prepare at the same time those dishes which take the same kind of materials and mixing. We should sit down to work when we can, and should have a chair or stool of convenient height. Bowls and mixing dishes, when screwed firmly to a table, require no energy to hold them securely.

In sewing, we should cut out the garments which are alike, or almost alike, at the same time; then stitch all the seams, hem all the hems, and so on until the work is done. This will save time. It will help if we choose our days and hours for each set of tasks with the hope of getting through them without confusion. (See also "System in Farm Housekeeping," p. 165.)

## Recreation for the Farm Family

Let us decide in our own minds why we are running our homes. Is it just a bitter toil, necessary because we have become wives and mothers? Is it to win fame among neighbors as fine housekeepers? Or is it for the sake of making our families as healthy and as happy as possible? If the latter is the case, then it is a part of our housekeeping, a part of our purpose, to keep ourselves "good fellows" for the sake of husband and children, and to provide for the family leisure and play as well as shelter, food and clothes.

**The need of it.** Wastefulness has been one of the mistakes of American life. Now, as one of the results, we have worn-out farms and often, too, worn-out men and women. Therefore, one of the important tasks of the farm home is to put back into the workers by means of play, the energy which has gone out of them in the form of work. Good times are the clover, the alfalfa, the nitrogen-producing crops of the home!

No family so much as that of the farm is dependent on itself for amusement, because community life, even in neighborhoods where it is most active, is hard to reach. The creation of leisure and the good spirits put into play are, therefore, matters of great importance and depend almost entirely on the housewife. If she shoulders the responsibility of making them a part of her housekeeping, she may look forward to the reward of a family whose efficiency is truly increased—as the productivity of the soil is increased by crop rotation—and to a household of young people who can feel that their best good times are enjoyed on the home acres.

An 8- or 10-hour day can hardly be enforced in the country, yet it is possible to come much closer to it than is ordinarily done. What is necessary is for the housewife to have in her mind a time limit for her work, and to hold as closely as possible to it. If she does not set any limit to her hours of toil, except a few for sleep, she is sure to become a drudge, for there is always something more that can be done. Therefore, she must learn to stop after a certain amount of time has been spent on the home tasks, although she may know that more work remains to be done.

**How to get it.** Certain hours should be set aside for family play. Saturday afternoons, for the children, at least, should be vacation time. Work should be made lighter

FIG. 117. Good times are the clover and alfalfa crops of the home. Let all the family share them

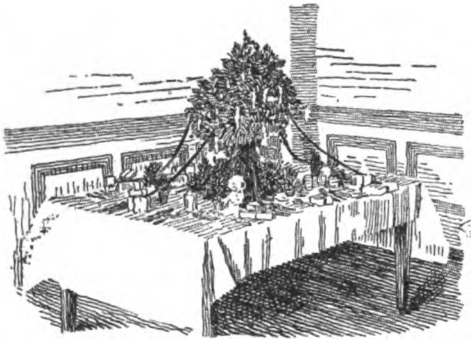


Fig. 118. Table decorations for birthday and holiday festivals bring cheer and variety at a cost of but little effort and less expense.

on Sundays. The farm woman should not have to prepare a big dinner on the day we are commanded to rest. Most people eat too much rich, heavy food at all times, and especially on Sundays.

Birthdays should be celebrated by little parties. Picnics bring real refreshment. At some season of the year, each member of the family should have at least a week's vacation, leaving the home and getting inspiration from new surroundings.

There are the absent members of the family, the grown-up children, whose places are always sadly vacant to mother and father. They, too, have a duty to the life of the family in which they were reared, and should make every effort to get home on such festivals as Thanksgiving and Christmas. The power to give the joy they can by returning, should more than repay them for the loss of any more exciting celebration among strangers. Festival days ought to be filled each with its own flavor and spirit. Let the old-fashioned Thanksgiving dishes, so far as economy permits, load the table. Let Christmas smell of evergreens and sparkle with tinsel and shining, many-colored balls. These things lie around the very heart of family life.

**The automobile.** The automobile is responsible for many of the changes in country life. It is giving pleasure daily to thousands of farm families. "For to behold this world so wide" is a desire of almost every human heart, and to speed along strange or only half-familiar roads, to rush past houses where lives unknown to us are being lived out, supplies just the relief which we need from the pressure of our daily toil. Different from this refreshment and even more important, is the opportunity an automobile gives us to reach friends whom we could not reach on foot or with a horse; the chance to get to church, to clubs, to stores. If our own homes are to be stocked with cheerfulness and good humor, we must get out of them sometimes and draw upon the funds of wisdom, good sense, and fun which are stored in other homes. We must visit our neighbors. Although telephones bring us a sense of companionship and many a pleasant chat, still they can not take the place of visiting. We need to watch the light in our friends' faces to see them at work, to gather to ourselves the spirit of their family life.

However, to enjoy this pleasure, like other pleasures, one must have a free mind, and the car should not be purchased when, in order to do so, the home itself is endangered by a heavy mortgage, or the dollars which had been laid up for the rainy day must be used. Before buying, one should be able to see clear through to paying for the car and maintaining its upkeep, including insurance. On some farms, an automobile is a source of income, making possible the quick marketing of produce and serving many other farm purposes. (See also Volume III, Chapter 4.)

**Vacations.** Some families tell of refreshing vacations spent in a tent or tents on the home grounds. The house is thoroughly emptied of provisions which would spoil, and is locked up as if the family were gone on a journey; it becomes almost a matter of honor not to enter it. On some shady spot near water, and preferably out of sight of the house, the necessary number of tents for cooking and sleeping are set up. A kerosene or gasoline stove is put in the kitchen tent together with whatever other equipment is necessary for the simplest picnic fare, for in order to enjoy this vacation, life must be reduced to its easiest and simplest. Cots are set up in the sleeping tent, or the ground may be covered with waterproof cloth and mattresses, or blankets or boughs may be stretched upon it for sleeping. A bowl and pitcher, a box of trunk, tables, and a few comfortable chairs, and the camp is complete.

Out under the trees the simplified life of the family goes on. There are no rooms to clean, so the housekeeper has time for reading. She should bring with her just the books which give her most delight. It may be that this nearness to nature will turn her heart to poetry, or she may long to increase her sense

Fig. 119. Just because they live and work in the country, is no reason why farm folk should not enjoy picnics and other vacations.

of change and distance by plunging into the lives and habits of other people and countries, through novels and stories of travel. Again, she may find her greatest delight in bulletins showing her how to perform more easily the tasks to which she must presently return. The point is that she should choose what rests and refreshes her, never forgetting that this is vacation.

The children should romp, play games, and be care-free. Carpentry adding to the comfort of the camp will interest the boys; and sewing of a favorite kind will increase the girls' enjoyment. Reading aloud while handiwork is being done doubles the pleasure of the hours. Possibly the farmer himself will at first consider this vacation at home a silly performance, but he is on record as becoming a convert to it in a day or two. It cannot fail to be a satisfaction to feel that the family is having a rest and a good time with the expenditure of very little money, especially when that expenditure is for equipment which can be used many times.

Portable houses have become popular of late. They are more expensive than tents, but still within the reach of those who have but little to spend. They can be carried in an automobile and set up by any handy man or woman, and they are weatherproof and solid. Hotels are often willing to have them placed rent-free on their grounds, the table board of the occupants compensating them. Such a house will bring many a pleasant trip within the means of a farm family.

It is worth while to watch in the newspapers for the advertisements of railroads and steamboat companies, showing special rates to certain places for a week or two. These corporations will also supply information about hotels and boarding houses on request.

Expositions, fairs and institutes offer opportunities for many pleasant trips. True, these require some work and study, but it is possible to obtain rest almost as thoroughly by means of a change of occupation and scene as by being idle.

There are various ways in which the members of the farm family may enjoy themselves. One large family in which there are many grown sons, each with his own family, has for years enjoyed an annual squirrel hunt which is made an excuse for a two or three days' outing in the woods. The hunting grounds are only a few miles away, so that the journey is one on which the smallest children may be taken safely. On these trips the aged grandparents, the grown sons, and the grandchildren are brought together in a happy, care-free way.

Another family, in which there are several grown sons and daughters, camps each year near the state fair grounds. In addition to seeing the fair at but little cost, all have a fine outing together.

On some pleasant day in autumn, it is fine for all the members of the family to spend a day in the woods, gathering nuts. There are also many other opportunities for family gatherings. The neighborhood picnic, in which several families whose farms adjoin or lie near one another combine, is also well worth while.

The best thing about all the pleasures in the country is that they may be homemade instead of being bought ready-made. Then, too, the outings are held where conditions are such as to make them healthful and productive of well being and right living.

The beautiful part about a vacation is that it lasts long after it is over. It even takes on new interest as it lives in the memory. It keeps on warming the heart and brightening the mind, and lasts as did the widow's cruse of oil. It gives the members of the family more to talk about together. So those little bickerings and misunderstandings which sometimes come up between members of the same household—no matter how much they love one another—are kept out because there are other things to occupy the mind. Perhaps the best test of a successful vacation or party would be: "How long is it going to last in our memories and increase the good nature and sociability of our family life?"

## The Problem of Hired Help

The problem of hired help, both in the house and in the fields, is yet to be solved. In fact, instead of being settled it becomes each year a still bigger and more difficult question. The city woman has trouble keeping servants, but her troubles are small as compared with those of the farm woman. In the first place, it is very much more difficult to keep a hired girl in the country. In the second place, the farm woman has the added problem of the hired man, frequently of providing him with board and rooming place.

### Help in the House

(*By* Ruth M. Boyle)

**The scarcity of help.** A good many of the housewives in the country, after many unsuccessful efforts, have come to the conclusion that they cannot keep help in the house. While a few are succeeding, they represent the exception rather than the rule. Undoubtedly, wages for women workers in

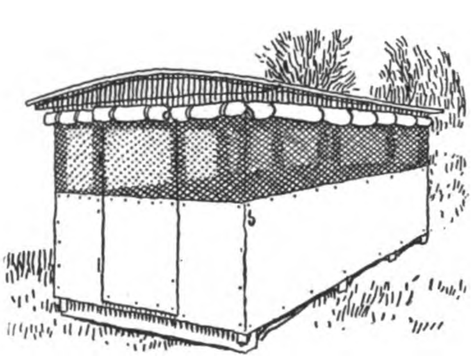


FIG. 120. A portable house provides excellent vacation accommodations for the whole family and can be taken on a picnic packed away in an automobile trailer.

the country, in many states, have been too low. However, where pay has been increased, help has continued to be just as hard to get as it was when wages were lower. In practically every state where surveys of the labor situation have been made, the same conditions have been found. Because of the scarcity of help, many country families are moving to the cities and towns in order to lessen labor, which, in many cases, has proved too heavy for the housewife to keep up year after year. This movement from the farm to the city is of more than individual or family interest. It is, in fact, a national question. If we are to maintain a high standard of life, we must continue to have in the country as high a class of citizens as the nation develops. But first of all, there must be kept on our farms a sufficient number of producers to feed the millions whose homes are in the cities. So the question of how the housewife is to keep help, or how she is to get along without it, is really of very much more importance than it might at first appear.

**The attraction of work in town or city.** While higher wages—or, at least, what may seem to be higher wages—have, no doubt, caused many girls to prefer town or city homes to country homes as places in which to work, there are other considerations. One of these is a shorter work day. Another is more opportunity for pleasure and recreation. The wider use of labor-saving machinery and the greater number of modern conveniences in the city home also prove attractive to the girl who cooks or does other housework.

**Keeping help in the country.** Of course, we cannot, nor would we, have conditions in the country the same as in the city. We cannot put a motion picture show on every farm. We can, though, through community effort, provide some kind of recreation and entertainment for all. A little thought, too, will often make it possible to interest the hired girl in some of the farm work by making her a partner, perhaps in the poultry business, in the garden, or in fruit production. Short hours every day in the year are not possible on the farm, but by careful planning of the work some of the trials of even the most strenuous seasons may be done away with. Of course, a comfortable room, all for her very own, will go a long way toward making the hired girl satisfied. In the country, too, where people are thought of more according to what they are than what they do, the hired girl who is worthy may enjoy social privileges which she cannot have in the city. The greatest aid, though, in keeping help in the farm home will come through the use of labor-saving machinery, including modern heating, lighting and water systems. Of course, there is just as much difference between hired girls as there is between the women who employ them. To think of all of either class as alike would be wrong. In the solution of this problem, as with many others, understanding and sympathy, together with fair pay for services rendered, will help.

## The Hired Man

(*By* WM. L. NELSON)

Not all farmers employ hired help. Of those who do, some use it for only a few weeks or months during the busy season. Others prefer to keep at least one man all the year round. The latter plan is by far the more satisfactory provided there is at all times work enough to keep the hired laborer profitably employed. The hired man of the right kind, unless he is a specialist, generally prefers an all-the-year-'round job; while, as a rule, the man having a family will not consider short-term employment. (Chapter 5.)

On farms where at least one man is kept all the year 'round, the most satisfactory arrangement is to hire a married man, and provide for his family as comfortable a tenant house as can be afforded. It may be that this man will board the extra hired men when they are needed. If so, the problem of regular help will be lifted from the shoulders of the farm housewife.

In many cases, such an arrangement cannot be made. The farm mistress, then, must board the hired men herself. It may be that these men sleep in the same house, and in winter at least, spend their evenings in the family sitting room. Under these conditions, the most important fact to the farm woman is not that she will be required to do so much more cooking, or clean an extra room, but that the men her husband hires are going to live in her home in close intimacy with all the members of her family. Children often come to think a great deal of the farm help; it is most important, then, that the influence which these men have over the youthful minds be a thoroughly wholesome one.

**Giving the hired man his due.** The man who can be taken into this close intimacy in the family, has certain rights in his turn. He has the right to a clean, comfortable sleeping room, to wholesome food, and to the same kind and amount of courtesy and consideration that is asked of him. He may not care to spend every evening with the family any more than they wish to have him. He should, therefore, have a stove in his room, a good light, and a table at which to read or write.

On a farm where several hired men are employed, one of the best plans for saving the housewife and giving the family privacy, while at the same time making the men contented and comfortable, is to have a hired man's room—not a bunkhouse or place for them to sleep, but a room in which they may gather to read and talk or write letters on Sundays and after work hours.

Such a room might be provided with washbowls and towels so that the men could come to it directly from the fields instead of going through the kitchen. It should, of course, be easily reached from the dining room. There should be a row of hooks on which to hang hats and coats, and some provision should also be made for other possessions. A built-in seat, chairs, and a table with farm papers and writing material should be provided also. On some farms such a room might also be used as the farm office.

Many farm women complain that hired men are not personally clean, and for this reason are not pleasant to have in the house. In many cases the fault lies less with the man than with the farmer who fails to provide bathing accommodations except the washbowl and roller towel. Under such conditions, in winter especially, the men become very careless; but generally this can be avoided by providing suitable bathing facilities.

**Plans for keeping help.** The problem of securing help in the fields is not yet such a difficult one as that of getting help in the house. Each year, though, farm help is becoming more scarce. As has been said of the hired girl so may it be said of the hired man, that, while wages have, very properly, been advanced, workers have become harder to get. In some sections, especially during times of war or unusual demand for laborers on the part of manufacturers, crop acreages have been reduced because help could not be had.

How to meet this problem of a shortage of farm help is a big question. Many plans have been proposed but not all of them will work; in fact, only a few suggestions seem worth referring to here. To make the quarters of the hired man, whether he be single or a man of family, comfortable and pleasant is well worth while. A limited form of profit-sharing in crops or stock, returns from a few acres of ground, or some live stock as his own, have proved helpful in keeping the best men.

**Fig. 121.** The farm family has both need and opportunity to provide its own recreations; games are invigorating sport for young and old.

Some farm owners have done away with the vexations of men leaving just when they were most needed by giving bonuses in the form of extra pay to those who stay throughout the year. In order to secure at all times the best work and the greatest amount of interest from the men, the plan of allowing a certain per cent on the year's returns from the farm, has also been put into practice in some places. Where men are hired at certain wages per month on a year's contract, it is always a good plan to provide for more pay for harvesting, threshing, silo filling and such work requiring extra help. There will then be less cause for the regular help's "flying up" on the job, and even the most faithful will feel better satisfied under such an arrangement.

**Feeding threshing crews and other extra help.** Every farm woman, at some time during the year, has to provide for a crew of men—the harvesters, hay balers, silo fillers, or threshers—ranging in number from half a dozen to 20 or more. Then it is that the managing ability, the judgment, and the strength of the housewife are put to the test.

Neighborhood customs have much to do in determining just how these larger meals are to be prepared and served. In some communities, the custom is for the women whose husbands usually join forces on these big jobs also to take turns at helping one another. In other sections the woman who has a crew of men to look after, relies upon hiring extra help or doing the work herself, possibly buying bread and some other articles of food.

FIG. 122. Canning outdoors. With all the beauties of the country close around her, the farm woman should find or make it possible to enjoy more of them in the midst of her work.

# CHAPTER 12

# The Farm Woman

WE speak of the farmer's life and work as complex and varied, but certainly the duties of the farm woman are no less complicated, no less varied and, above all, no less important. For she is not only the "food administrator" of the farm—with all the responsibility that the supplying of fuel for hard-working and hard-playing bodies involves,—but also the guardian of clothes; the high priestess of the hearth and the living room; the living expression of the "first aid" idea; often the regulator and timekeeper of all home activities and family plans; and ever the source of assistance, comfort and cheer for whatsoever member of the whole farm family needs help or advice. Sometimes, it is true, her ability and willingness to fill this many-sided office are not realized, taken advantage of, or appreciated. More often, however, everything she can give, is sought,—but, oh, so little is given her wherewith to make her tasks, even the ones she loves, easier! One of the greatest advances that has come in agriculture has been the improvements along the lines of labor-saving systems and devices for the farm home. Yet this same field remains one in which a very great deal has yet to be accomplished.

This chapter covers the four phases of the farm woman's domain. The first deals with system in housekeping; its value and how to attain it. The second considers the various phases of the food problem—the planning, preparation and serving of meals and special food materials. The third treats what may be called farm furnishings—the choice and care of textiles, bedding, linen, etc., as well as the principles of sewing and of home laundering. The fourth covers the essential points in the care of the sick on the farm. Every woman may feel—and many of them with every right to do so—that she knows more about her own housekeeping than any one else can tell her. Nevertheless, persons who have made special studies and experiments into this field, realizing and taking into account all its sides, have arrived at certain basic conclusions which can be of the very greatest benefit in many a home. It is these principles and their general application, rather than specific directions, that are discussed here.—EDITOR.

# A. SYSTEM IN FARM HOUSEKEEPING

*By* MRS. VIRGINIA C. MEREDITH *of Indiana who can lay claim to the titles of teacher, writer, editor, lecturer, farmer and farm woman in all that the name implies. After the death of her husband in 1882, she assumed the active management of their farm—one of the oldest in the region—and its herd of purebred Shorthorns and flock of Southdowns. Here for 30 years, and later on a new farm which she herself developed, she has achieved notable success as a breeder and exhibitor. Meanwhile she also became deeply interested in the modern development of home economics, and, when the University of Minnesota opened its school of agriculture to women, she was called there to start the work, with which she remained for 6 years. During that time the expansion of the field of extension work offered an attractive opportunity for further service, and she has ever since been active as a speaker in Institute and Short Course work in many states. Meanwhile she has become a contributor to the agricultural press, her writings covering a wide range of subjects relating to livestock, the farm in general, the farm home, and the farm family. Her acquaintanceship among successful breeders, and her activity in progressive organizations have had a further broadening influence that increases her ability to tell other farm women the things they want to know, in the way they want to be told them.*—EDITOR.

AN overwhelming majority of farm women in the United States is composed of individual women who perform all the labor of their own households with perhaps some little irregular help given by children. The daily tasks of each woman are such as belong to the mistress of a home, the mother of a family and to general housework. They include everything from the rearing and disciplining of children, the entertainment of visitors, the buying of clothing and household supplies, the selection and preparation of food, to every kind and description of cleaning, including the scrubbing of floors and the adequate ventilation of bedrooms.

Naturally the performance of this varied work requires a high order of intelligence; fortunately, intelligence may be acquired and developed almost without limitation. Inevitably this work requires for its performance a large share of the working hours of each day, and these hours are limited; they cannot be lengthened or multiplied by any means whatever. It follows, therefore, that if the housekeeper cannot add to her available time, she may, and indeed must, use whatever time she can command in the very best way. It is her part not only to discover but also to use a system suited to her house and to her family. This system will develop a plan to save her own labor, time and strength, while at the same time promoting the health, comfort and usefulness of the family. The efficiency of the system will depend upon the worker's knowledge and use of good methods; also it will depend greatly upon the tools with which she works.

Efficiency in any field whatever, in household management as well as in civil engineering, is based on a clear understanding of the problems to be solved. Unfortunately a full comprehension of its problems may easily escape persons engaged in an unorganized and complex industry like housekeeping, where there are no recognized nor accepted standards either in quality, labor or scale of living. In every community, however, there are some women who, by knowledge, experience and executive force, have mastered the complex business. They seem never hurried, never behind time, meals are well chosen, well cooked and served regularly; children are clean and suitably dressed; the house is always in order; canning and preserving are promptly done in season; they have time for visitors and visiting, for the club and for church.

**A practical housekeeping plan.** An analysis of the system used in one well-kept house ought to furnish the basis for a working plan for every house. While it is quite impossible to make a plan that suits every home, it is likewise impossible to make a plan that will suit the same home every week in the year. Nevertheless, a plan may be found that has coherence, however elastic

the administration of the plan may be. A suitable system is always the result of an adequate survey of what needs to be done plus an estimate of the labor, the knowledge, and the time available for the doing of it.

### The Elements of Perfect Housekeeping

Every house, speaking broadly, has 3 centers, namely, a labor center, a living center and a sleeping center. To manage and bring these into proper relations, one to another, and each to the fundamental needs of the particular family they serve, without overemphasis of one or neglect of another—this constitutes perfect housekeeping.

**The labor center** (p. 168) is primarily the kitchen, where food is prepared and where dishes and utensils are cleaned. It also includes the laundry where the cleaning of soiled clothing is an essential task. System in this center is based on a correct knowledge of methods, while efficiency is dependent largely on the tools that are used.

**The living center** (p. 173) is the family sitting room where all meet to sit, talk, read, study or play, and the dining room where the family comes together at least three times a day. The living center is the heart of the home, it exists for the development and enjoyment of each member. Efficiency here is dependent upon the knowledge represented in the selection and use of furniture, floor coverings and wall decorations and the choice and care of a system of lighting and heating.

**The sleeping center** (p. 175) where about one third of the life of each member of the family is passed, determines in a marked degree the personal health and usefulness of each individual. Efficiency in this center is dependent upon the knowledge of sanitation and hygiene which the housekeeper is able to express in her purchase of bedding and its subsequent care, and through her plan for ventilation. Efficiency in this center is peculiarly important because, when asleep, one is unconscious and cannot change conditions; moreover, the physical system is relaxed during sleep and so is very sensitive to whatever conditions, good or bad, the housekeeper may have created.

FIG. 123. Is washday in *your* house a laborious, primitive, disheartening chore like this?—

**Family habits** may promote good housekeeping or, on the other hand, they may render it impossible. Family habits may "just grow" like Topsy in "Uncle Tom's Cabin" or they may be established through coöperation and by long and laborious teaching, by precept and example. Where right habits, related to housekeeping, are established, they contribute strongly to the smooth running of the household machine, they become, in fact, a priceless lubricator that reduces wearing friction.

**"A budget** is a detailed plan of anticipated income and expenditures for some definite future period of time, as a week, a month, a year; it is intended to control expenditures during that period." The housekeeper is concerned with the expenditure of labor, knowledge, time and money in whatever pertains to the home. The expenditure of money is constant in 4 distinct lines: (1) for existence, (2) for comfort, (3) for culture, and (4) for philanthropy. A wise distribution of the income along these lines is most surely accomplished by the forethought that grows into a plan which is called a budget. Modern housekeeping recognizes in the budget a dependable basis for efficiency in equipment and maintenance.

### A Plan for the Week

**Sunday,** according to the calendar, is the first day of the week, but in the American home it is practically the last day—a climax toward which all the interest and activities move, making it a day for family life at its best. The family ideals determine, not only its use, but the nature of the household work for the day. One family translates the thought of a day of rest into habits of laziness, another considers it a day for feasting and emphasizes the heavy Sunday dinner; one believes it to be for the promotion of neighborliness and devotes the day to visiting, another thinks it is intended to be a change from the labor of the other six and gives it to recreation and outdoors. Modern ideals of parental duty may produce a special responsibility on the part of the father toward the small children so that he assumes a Sunday care of them that turns the day into one of comparative rest for the mother. Some hold to the old and venerated ideal which sets apart the Sabbath to be a time for religious instruction and worship; these attend church and Sabbath school.

**Monday** usually finds the entire house in more or less disorder after the semi-holiday of Sunday; therefore it becomes the logical time for setting in order, sweeping, dusting and doing light cleaning. It is, too, a convenient day for baking and any other general preparation that will reduce the cooking for the following day, which is to be washday. The clothes that are to go into the weekly washing should be collected and looked over; there will always be some articles that need the kind of mending which can be better done before, rather than after laundering, such as darning table linen, and mending lace and other garment trimmings. Assorting and mending the clothes and putting to soak overnight such as require it, is a plan of work that divides between two days the time and labor that are required to do the family washing. Consequently it reduces the weariness of the task as a whole.

Tuesday should be the universal family wash day. It is early enough in the week to permit the ironing to be finished without dragging along to the very end, and yet it has a previous day of preparation, not only for the washing itself, but for lightening the daily work of household routine with its inevitable three meals on wash day. The plan of Tuesday's work will include an oven dinner, which reduces the necessary attention and labor given to the preparation of food.

Wednesday. Whether or not this shall be ironing day is a debatable question. For many women, it seems desirable to separate the washing and ironing, both of which demand that she shall be on her feet almost continuously. The intervening day may well be devoted to sewing or some similar work that admits of sitting. There is a too prevalent tendency to conclude a piece of work by hurrying to "get it over," that may lead to an intemperate devotion to the task itself without a due recognition of the fact that efficiency is not so much a matter of time as it is of methods which finish the work in hand and then leave a residue of energy and a state of mind capable of enjoyment. If ironing is to be done on Wednesday, it deserves to be done with good tools that save the time, labor and comfort of the housekeeper. The built-in ironing board and the self-heating smoothing iron are conveniences adaptable to every home and at a cost within the reach of every farm woman.

Thursday is the day when the unusual, irregular, but necessary things may be given attention; there are a general looking over of cupboards and household stores, the polishing of silver, airing of bed clothing, and kindred tasks that can be grouped or separated. The attention to household stores is a matter not merely of cleanliness and order, but also of economy, when overlooked supplies are brought forward for use while they are usable. In this connection there is a bit of work that

FIG. 124. Or have you taken advantage of modern inventions to make it merely an item in an interesting, varied, enjoyable life of activity?

may properly belong to this day, namely, the planning of meals for a week. Competent stewards in hotels and restaurants plan the meals for a week or more in order to economize in material by properly combining foods. The housekeeper in her narrower domain can lighten her labor, save materials and reduce cost when she has a plan of meals for consecutive days. Such a plan is workable when it becomes a matter of personal trial backed by a thorough belief in the wisdom of devoting brains, as well as time, to everyday uses.

**Friday** is popularly considered as sweeping day, although the housekeeper who is enterprising enough to have a plan for the week is likely to make every day a cleaning day, in a limited sense at least. With her housekeeping well in hand, she may keep Friday afternoon for visiting, or permit the claims of a club composed of a group of neighbor women to have first place; it may permit a trip to town for shopping, or an hour of enjoyment at the public library, or a real visit to a relative. Such use makes this an important day and its privilege is a duty, which, if properly discharged, is far from being a negligible part of housekeeping, because it brings into the home new topics of conversation, forms taste, and fosters friendships that have lifelong influence. These things of sentiment are so dependent upon efficient housekeeping in their opportunity for expression, that the housekeeper must estimate them as a part of her plan.

**Saturday** is the busy day when cleaning house and extra cooking in preparation for Sunday take a prominent place in the day's work. Putting on fresh sheets and special care of the beds, getting clean clothes in order for the family and readily accessible, all these require time and must not be neglected.

## Planning for the Seasons

After the Christmas holidays, when the days are beginning to lengthen and before outdoor activity is possible, is the logical time

to accomplish household sewing; the time when the store of sheets, pillow cases, tablecloths, napkins and towels may be replenished for the year; when aprons, wash dresses and undergarments may be made up. With this general and necessary sewing out of the way, that which is special and seasonal, like summer or winter dresses, is not burdensome.

Early summer brings the important work of putting away winter bedding and clothing with the necessary cleaning and protection from both dust and moths. This season, too, is the time for making jellies and jams from the berries and small fruits. The work in this connection is much lightened if jars and glasses as soon as emptied are thoroughly cleaned and put away secure out of reach of dust, preferably in their original pasteboard cartons. In this way the labor connected with their sterilization is made inconsiderable.

Later in the season there is care of the vegetable garden, the canning, drying and preserving of the larger fruits and the storing of vegetables and fruits for winter use. Last in the year is the heavy work of rendering lard, making sausage and other items connected with the home curing of meat.

The distribution of this seasonal work, when it finds the housekeeper prepared to despatch it, is easily managed. It becomes burdensome only when there is no plan or preparedness.

**Making housekeeping easier.** There are six main sources of information relating to changes and improvements in housekeeping, namely, bulletins issued by the U. S. Department of Agriculture and by the extension departments of the agricultural colleges; attendance at farmers' institutes; membership in homemakers' clubs; the advertising pages of the better class of farm journals; catalogues of reliable firms; and visits to well-equipped homes and to big stores.

These sources of information fall into two groups since the first three relate to methods, and the second three to adequate equipment. Under some circumstances, an improved method may save as much time and labor as a good tool. This is illustrated in the making of bread at home; when the short process is used, there is no setting of sponge over night, little kneading is required, and by baking in single pans, a thoroughly good and palatable loaf is secured. That good tool, the bread mixer, saves both time and labor when many loaves are to be made at one baking, but on the other hand, the care of the mixer itself requires more time and labor than it saves when only two loaves are made. The short-process method is just as valuable with many loaves as it is with few, while the bread mixer, as a tool, proves of greatest value only when many loaves are made.

The increasing lack of household help that is at all helpful is one of the main reasons that are causing the housekeeper to seek improved methods and better tools, and to spend on these the money she would willingly pay to a competent helper.

FIG. 125. The kitchen must always be a labor center, but it is for the farm woman to make that labor a happy, productive, broadening one, not merely a chore.

### The Kitchen—the Labor Center

In the kitchen, the greatest single factor in saving labor is in the nature and arrangement of its furnishings. The work performed there falls into 2 main groups: (1) the collecting of materials and utensils for the preparation of meals; and (2) afterward, the cleaning and putting away of the utensils and the disposal of "leftovers." Hence it follows that the position of stove, table, cupboards and sink in their relation to each other is an important point in saving steps. A long room rather than a square one, suits

FIG. 126. Too many farm homes mean drudgery and wasted energy.

the most convenient plan, that of having the main furnishings ranged around the walls.

The painted wall is first choice. Often, however, this must be modified, but always, from a sanitary standpoint, the use of a wash is to be preferred to paper. Where the floor is laid with good flooring, it should be left bare; if oiled at intervals it will present a good appearance and will nor require undue labor in its care. Linoleum is a desirable covering that secures warmth. It is easily kept clean and bright with a mop, using no soap but adding 1 part of skimmilk to 10 of water. The bare floor, if rough and uneven, is not a suitable base for linoleum and, much less so for the cheap grades of oilcloth and fiber coverings; such a surface should first be covered with building paper.

**Water.** Water shares with heat a first place in the kitchen equipment. Providing an ample and convenient farm water supply requires an outlay that in some cases amounts to half as much as the cost of the comfortable house it serves, yet it may be an economic answer to an hourly demand. The water system, when installed, saves labor and time and promotes health in a satisfactory way. In an old house, the water from the cistern can be brought into the kitchen with little expense. A galvanized iron pipe and the ordinary pitcher pump will deliver it at the sink. This operates easily and saves many steps and much heavy lifting.

The white enameled sink and the pump should be built in with a work table extending along the wall, with the sink directly in front of a window. The housekeeper and no other should decide how high sink and table shall be from the floor. The drain board will be at the left of the sink with the pump at the right. The table 2 feet wide and 5 or more long, is an extension of the frame that holds the sink and pump. The whole structure should stand on legs, and be open beneath, not with closets. The waste water is carried away by a pipe with a trap and well-laid tile. This simple addition to an old kitchen may be made by any carpenter and at a moderate cost. The top of the table should be heavy and of one piece. Cypress, although soft, is a satisfactory wood that may be had in wide sizes. Any wooden table top, however, may be covered with zinc. Should one not wish the covered table, zinc forms at least a fine facing for the wall back of the table. It is easily kept clean and with a long 8 inch shelf above it completes a good type of kitchen work table. Many housekeepers will find a small movable table a convenience for extra occasions.

**The kitchen stove or range.** The first decision that must be made by the housekeeper is whether the cooking range is to be used for the one purpose of cooking or shall it serve also as a heating stove. If there should be a furnace in the house, the decision is already made. If there is no furnace, then there remain two choices, the first being a cook stove that is also a heater. The objection to this is that during the summer it renders the kitchen a very uncomfortable place for one who must spend a large share of her time there. The second choice is a range which uses gas and depends upon an ordinary heating stove for winter use in the kitchen. The advantages of the gas range are that it reduces the time and labor needed for cooking meals, it gives a better control of the oven, and does away with unnecessary heat in summer; it does not require a chimney and therefore can be placed with its end near a window in order to secure the best light, without any regard to the location of the chimney. The later models of gas stoves using gasoline or coal oil are so constructed as to be entirely safe under the management of a careful housekeeper.

**The fireless cooking range.** The best adaptation of the principle of fireless cooking

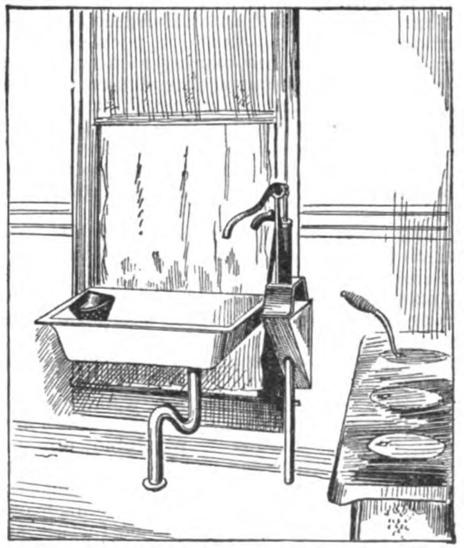


FIG. 127. A kitchen pump, sink and drain pipe in the kitchens should cost not more than $15, and get result in immeasurable saving of time, energy and health.

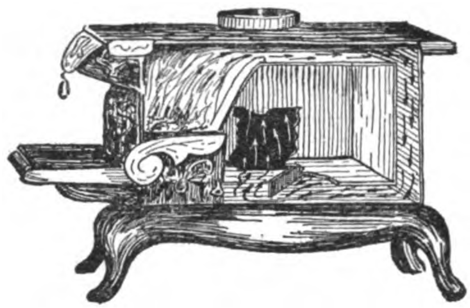


FIG. 128. A modern coal range partly in section to show the course of the drafts

is the gas range which has an oven built to conserve heat so that when it becomes heated, the gas jet may be turned off, and bread and meats will bake perfectly without any further consumption of gas. The woman in town will probably prefer a fireless cooking range that uses manufactured gas, but for farm women a range that uses gas generated from gasoline or coal oil is the only choice, unless acetylene gas is available. Those of the latter type come in acceptable styles and at moderate prices. Gas cannot be generated from gasoline in a cold room, and to some persons this is an objection to the gasoline range, but the reduced labor and cost of fuel required for cooking on a gasoline range the entire year will more than offset, in most cases, the labor and cost of heating the kitchen either by furnace or by the inexpensive small sheetiron stove during the winter.

**The fireless cooker.** That the fireless cooker has failed to reach the full degree of popularity which it deserves is due, perhaps, to its misleading name; but whatever its name and whatever its reputation, the device itself is wholly reliable and a very great help to the housekeeper who will use it as directed. The principle expressed in its construction is that of saving heat that has been first secured in the usual way by the combustion of wood, coal or gas.

The compartment that receives the food which is to be cooked contains also the heated stones. This compartment, usually round, is made of metal and is placed inside a wooden or metal box with a space of several inches between the two. This space is packed with mineral wool or similar material that is fireproof. This plan of construction is intended to conserve the heat for a long period. With meats, and some vegetables, this long, slow cooking secures a palatable product very much better than can be secured otherwise. When such uncooked food as chicken, a beef or pork roast, or beans for baking is put in the fireless cooker it needs no further attention for 3 or 4 hours, and indeed, if left for a longer period will not be hurt in any way. It is this fact which constitutes the value of fireless cooking. The housekeeper may leave the Sunday dinner to cook while the family is at church and without any fear of accident from fire and with the assurance that a hot dinner will be ready on her return. An afternoon in town or at the club may be quite care-free when she is sure that all is going well at home. The fireless cooker is of especial assistance at harvest time or during corn shredding and silo filling when its compartments will take care of the heavy cooking. One should carefully read the instructions and recipes sent out by the manufacturers in order to learn what to attempt and what to avoid. The housekeeper will soon become mistress of the situation and know how dependable the fireless cooker is within its limits.

When buying a fireless cooker, one should investigate the different types, as each year witnesses valuable improvements that enable one to get more value for the same price than was possible previously.

**Cupboards.** Cupboards have such a useful place in the kitchen work that their construction and placing deserve especial consideration. When the kitchen is longer than it is wide, a type that has proved satisfactory in use is a double one, really two sets of shelves placed back to back with the usual doors opening out from the two sides. When this double cupboard is placed with one end against the wall, it has the effect of dividing the room to a certain degree. This style of cupboard should be about 4 feet wide and should extend from floor to ceiling. It will take care of table dishes, cooking utensils and grocery supplies, protecting all from dust and contributing much to the orderly appearance of the kitchen. Placed near the middle of the room, its double doors on one side will open toward the cooking range, which is at one end of the kitchen, while the doors on the other side of the cupboard will open toward the sink placed at the other end, with the work table midway between sink and

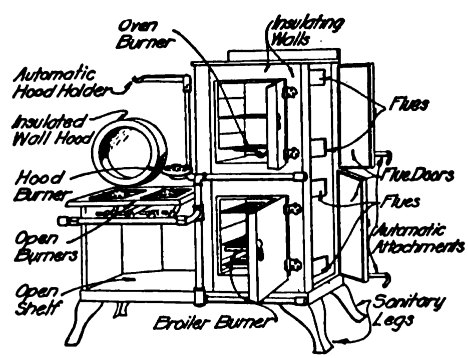



FIG. 129. Where city, natural, or home-manufactured gas is available, the gas range is a great comfort and convenience, especially in summer.

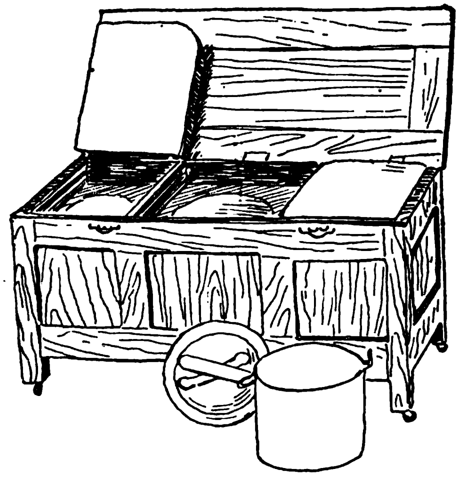


FIG. 130. The fireless cooker rightly managed is a great labor- and fuel-saver. It may be bought, as in this case, or made at home (see Fig. 105).

range. The upper section of this cupboard should have rather shallow shelves, the doors opening over an 8-inch extension that makes a convenient ledge about 40 inches from the floor. Here there should be drawers, perhaps 6 inches deep. The space below the drawers forms a lower cupboard with adjustable shelves. The carpenter who builds the work table can build this simple but very convenient arrangement of shelves with doors.

Another type of cupboard, liked by some as a step saver, is built in the wall between the kitchen and the dining room with doors opening into both rooms, thereby allowing the clean dishes to be placed on the shelves directly from the sink in the kitchen, and, when they are needed in dining room, to be taken directly from the shelf in that room.

**The dumb waiter.** The kitchen equipment may include a dumb waiter easily handled by ropes and used to convey the food placed on its shelf to the cooler cellar below, to be kept there between meals. This shelf, or waiter, moving in a vertical shaft can be made by any handy person and will save the housekeeper many trips up and down the cellar steps.

**Flour bin.** A container that is both convenient and clean is a hanging flour bin containing 50 pounds, made of tin and with a sieve at the bottom that is operated with a crank like the common flour sifter. The flour is put in from the top and securely covered with a lid. When the bin is hung on the wall by its wooden panel over the extra kitchen table, it will be found extremely convenient and economical, since no flour is wasted as is often the case when it has to be dipped out of a flour chest or sack.

**The meat grinder.** The meat grinder is an indispensable tool in the kitchen. In fact, its name does not convey an idea of its manifold uses. Probably no one service it performs is so helpful as the grinding of bread crumbs. The scraps gathered during several days, when dried crisp in the oven and put through the grinder, may be kept a long time if placed in a clean dry glass jar and left uncovered. Thus prepared, the crumbs are not only saved but they are a very quick help in making scalloped vegetables and fruit puddings. Nuts for cakes and for salad may be ground and kept until needed, and fruits, such as pineapple that is to be used in jams and marmalade, may be pulped in the meat grinder.

**Knives.** A full equipment of knives is essential in the efficient despatch of cooking processes. There are numerous kinds especially adapted to various uses. One kind that cannot be spared is the *bread knife* with its scalloped edge. This knife is used for no other purpose and should be kept hanging with the 12-inch bread board on which the loaf is sliced. The *paring knife,* short and sharp, must have a firm handle, preferably of metal and of a piece with the blade. Such knives should be bought in pairs or triplets. The dull heavy butcher knife or old case knife is not a substitute for the efficiency of a real paring knife. A *grape fruit knife* with its curved blade is almost indispensable in preparing grape fruit and oranges for the table. *Scissors* are extremely useful in shredding lettuce without bruising it and for clean cutting of fruits for salads. Until a pair of long-bladed scissors are included in the equipment, one does not realize their usefulness in the kitchen.

The pineapple and the strawberry nipper, with a score of other small conveniences, have a right place in the kitchen of every one who wishes to save her own time and labor and also secure satisfactory results in cooking operations. Inventors and manufacturers constantly add to labor-saving devices on sale in the big stores.

**Spoons.** Wooden spoons intended for use with fruits and acid mixtures are a welcome addition to the kitchen collection. Their noiseless operation fits them for beating cake batter, and they contribute decidedly toward saving the finish of utensils that are used when the stirring of the contents is necessary.

**Spatula.** The spatula, with its broad, long,

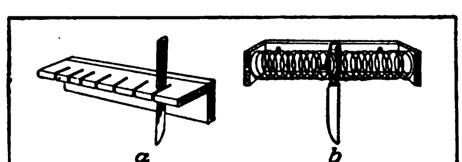



FIG. 131. Convenient kitchen knife racks: *a* is of wood; *b* is a stiff, spiral, wire spring

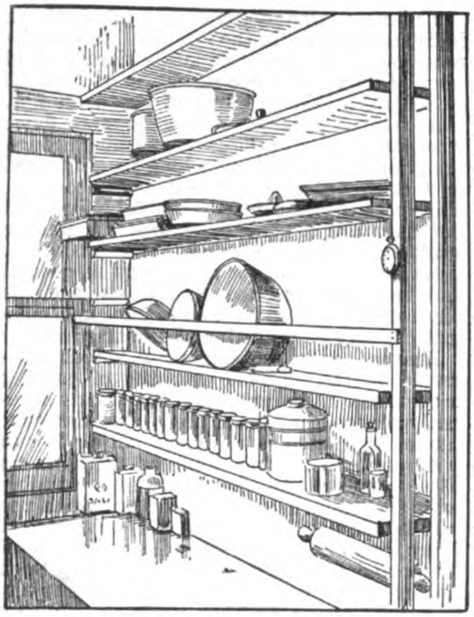


FIG. 132. A well-arranged kitchen work table and shelves. The wooden strip to keep utensils in place is better than tacks or a groove in the shelf.

thin blade and dull edges, is a valuable tool for turning food and for lifting it from the pan. For this it is so much superior to a knife that it is in constant use. It is helpful, also, in skillfully transferring the dough of cakes and biscuit from the rolling board to the baking tin.

**Utensils and wares.** Modern improvements are nowhere more marked in number and in value than in household utensils. The iron pot and skillet used in earlier times have been almost wholly superseded by many types of utensils and many kinds of wares that efficiently serve the housekeeper. The double boiler has now become more useful than the teakettle, combining as it does the two advantages of being easy to clean and making impossible the scorching of delicate food. Earthenware baking dishes are in almost universal use because they not only hold the heat, but also can be used in serving the food cooked in them, and are easily cleaned and scoured. The more expensive transparent wares are durable and attractive. Aluminum deserves its popularity on account of being light to handle and easy to clean. Tinware seems to be going out of use because of its poor quality of late years. Granite ware, except in the very best quality, has but a short life usefulness.

**The stool.** The introduction of the high stool, to be used at the kitchen work table, marks the development of a sane sense of the importance of saving woman's strength wherever and whenever this is possible. Many forms of work that could not be done when seated in a chair, can be done perfectly when seated on a high stool. Sometimes, and for some women, it seems vastly easier to get the stool than to get the habit of using it—doubtless due to a lingering tradition that bustle and hurry mark the capable woman, and with no comprehension of the fact that plan and poise distinguish the modern woman's efficiency.

**The basement laundry.** A generally approved model for a farm house includes a basement or cellar with windows large enough to admit ample light. When there is a gentle slope to the grounds, an outside entrance may be on a level with the ground. This has many advantages: (1) It permits having a washroom for the men which they can reach from the barns, on a level, and where extra clothing such as overalls and coats may be hung. (2) It gives easy access when storing apples and vegetables. (3) When water and a stove are provided, canning, butchering and washing can be done there, thus taking from the kitchen a class of work that entails more or less disorder and dirt. (4) If a motor is installed in the basement, it can pump water for both house and barn, run the cream separator, the washing machine, and the churn, and indeed relieve the farm woman of a long line of heavy work.

*The self-heating iron.* While the farm woman is denied the use of the electric smoothing iron, she can have a self-heating iron that uses gasoline. Such an iron is moderate in price, entirely safe, and the woman who once uses it would not willingly do without it. It not only saves steps and does good work in less time, but also saves fuel and the undue heating of a room. The price is within reach of almost any farm woman. *An ironing board,* when used in the kitchen, may be fas-

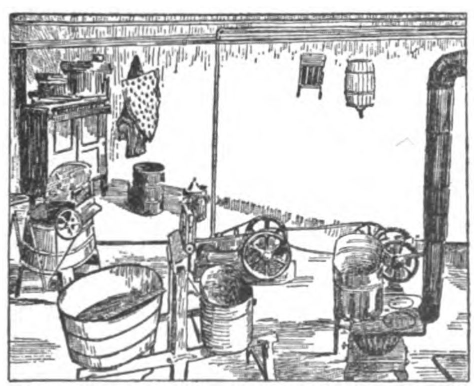


FIG. 133. A basement laundry with gasoline-engine-driven equipment. Washing can be done here in all weathers without disturbing or obstructing the kitchen.

FIG. 134. A handy mop wringer

tened to the wall with hinges, and, with its hinged leg, folded back against the wall and concealed by a paneled door, if desired.

Cleaning. Cleaning is the main business of housekeeping. Washing dishes and cooking utensils, scouring table and sink, mopping floors, laundering clothes, sweeping carpets, cleaning rugs, airing beds and rooms, constitute an endless routine that becomes endurable and is performed with joy only when the housekeeper has good tools with which to work and when she believes that cleanliness is a costly beauty and intimately related to health. Hot water, soap and plenty of clean wiping towels make dish washing fairly easy until some great inventor puts on the market a practical dish washer for family use.

Brushes. A full assortment of brushes contributes to the saving of time and labor and to thoroughness. The small, inexpensive fiber brushes should be bought by the half dozen, some to be kept exclusively for cleaning vegetables, like potatoes and beets, others for the sink, with larger ones for scrubbing. After using a brush it should be put away with bristles down. There are *scouring powders* to be had that are far better than soap in their power to remove greasy dirt easily and quickly. The various kinds have various uses. Better ones appear every season and these deserve to be sought out and used. *The mop* is useful within its limits. It will not reach corners but it is of great help in cleaning floors. The ease of operating it is increased when a pail is used that has a device for wringing the mop without the need of touching it with the hands. This device can be bought and attached to any pail.

Disposal of waste. Here, perhaps, more than at any other point, the housekeeper may demonstrate her mastery of her business. Everything that comes into the house must go out via some safe channel. Water needs a waste pipe to carry it to a safe distance or a safe place where it will not menace the health of the family; the sweepings from the floors must be disposed of in a cleanly, sanitary way, preferably burned. The waste from vegetables and fruits, such as parings, and the scrapings from cooking vessels and scraps of food past using, must find their way to the garbage pail, which should be covered and frequently emptied in order that it shall not become a nuisance.

## The Sitting Room—the Living Center

The labor connected with the care of the living center of the home depends upon the selection and use of its furnishings and upon the family habits of order.

The care of the floor. The kind of floor and its carpet, or rugs, are outstanding points of interest because the choice that is made in their selection determines the amount of labor that must be expended in their care. The expensive hardwood floor will have to be waxed and oiled, but its good appearance may be considered worth the labor. This floor admits the use of rugs which are regarded with favor, due, in some degree, to the convenience with which they can be taken out of the house for cleaning. The painted floor, which is much easier to care for than the hardwood, will, with rugs, meet the modern sanitary demand for less dust in the house. Many persons, however, prefer a floor entirely covered with carpet.

*The vacuum cleaner* is invaluable in the care of carpets and rugs. Its popularity is due to the thoroughness of its work. Dust and dirt are taken through the action of suction, di-

FIG. 135. The vacuum cleaner whether hand- or electric-driven represents the easiest and most hygienic method of keeping the house free from dust.

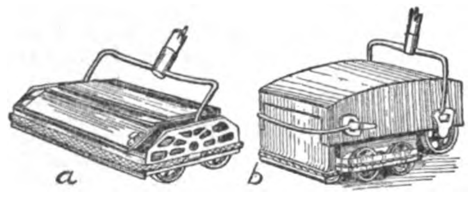



FIG. 136. Carpets and rugs require the use of a good carpet sweeper (a) or better still, the improved, combined vacuum cleaner and sweeper type (b).

rectly from the carpet, into a closed bag or box that can be emptied outside the house where they may be burned. The use of the vacuum cleaner not only reduces vastly the work of dusting everything in the room, but through the absence of dust prevents the furniture from growing prematurely dull and shabby in finish. While some farm women cannot make use of the type of vacuum cleaner that is operated by electricity or other power generated by machinery, yet they will find on the market styles to be operated by hand which are thoroughly satisfactory in the results obtained by their use.

*The carpet sweeper*, an arrangement of rolling brushes enclosed in a box, retains its usefulness because it is light and can easily be run under and around the table after each meal, and in the sitting room every morning, thus quickly brushing the surface and securing neatness while the thorough cleaning is taken care of weekly by the vacuum cleaner.

The draperies or curtains for the windows should be given especial thought and be made to serve the use of the windows. They should be hung to admit light freely and be of material easily cleaned. The color of the walls is important and it is not wise to be wholly controlled by fashion in choosing wall papers. One should remember that the plain papers of light tan, gray or cream tints are cheerful; while large patterns in the heavy reds, greens and blues, reduce the apparent size of the room and are depressing to many persons, although children, and even older ones, are not conscious always of what influence it is that irritates or depresses.

The lighting of the farm house is usually its weakest point in regard to efficiency; being denied electricity and manufactured gas, except in rare instances, the usual source of light has been the kerosene lamp. Probably few forms of work are as distasteful as the cleaning and filling of kerosene lamps, while the light itself is too often dim, dull and depressing instead of being cheerful and sufficient. There are now made portable gasoline lamps that are absolutely safe and give a better light to read and sew by than either the average electricity or gas; being without a glass chimney they practically require almost no care. Whatever may be done about the rest of the house, when there is no lighting plant installed, at least the family living room should be equipped with light that insures no injury to the eyes and illuminates every section of the room.

The open fire should be a feature of every family sitting room; it represents the sentiment of the hearth without which farm life would be barren and lacking in the essentials of personal development. The care of an open fire of wood or coal is much lessened when a chute opening from the hearth carries the ashes directly to the cellar below whence they can be removed at convenient intervals and thereby avoid their dust in the living room.

**Furniture.** *A large center table* is an essential piece of furniture; it should be substantial, plain in style so that it may be quickly dusted, and without cross pieces below, that would tempt the feet of children to mar its finish. It must be large enough to hold comfortably the papers and magazines in daily use and to give the children a place on which to study if they wish.

*Chairs* are found most satisfactory when the needs of each member of the family are remembered in their purchase, the small chair for the little tot, the strong, well-built armchair for the man, a restful low rocker for the mother. The mistake should be avoided of buying a chair for its looks disregarding its construction or comfort. Old furniture is the vogue, not because it is old, but because it was made by hand in a day when cabinet makers respected their trade and used only good material, building well and on good lines without meaningless frills.

A couch or lounge is a desirable addition to the living room, not for ornament, but to invite and permit the horizontal position, the value and restorative powers of which housekeepers sometimes fail to appreciate during the quiet time that every life needs sometimes during every day.

*Book shelves* give to a room a note of fine living that has no substitute; the dusting of books is a care cheerfully bestowed. A combination writing desk and bookcase may be convenient but will not prove as good a choice as separate shelves. But under any circumstances, there ought to be a convenient writing place, with its supply of stationery, pen and ink. Many farm people are negligent in the matter of business and friendship letters, often because of the lack of writing materials kept in a convenient place.

In hanging *pictures* on the walls of the home, one adds decidedly to the sum of labor required for its care. Therefore they should be chosen with deliberation, for a reason, and sparingly. One picture that is inspiring or restful is to be preferred to many that have no meaning. There are scores of pictures suited to an art museum for every one suited to hang in a home. A comparatively safe purchase is represented in reproductions of

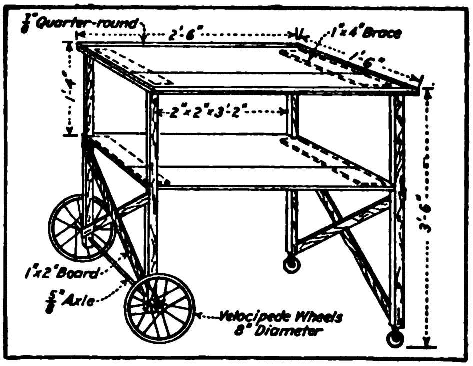



FIG. 137. Plan and dimensions of a tea-cart that can easily be made at home. With the scarcity of hired help, such aids have become invaluable.

pictures that have been endorsed by the good taste and judgment of cultivated persons. The choice among such pictures is so wide that it does not limit the personal preferences of any one, whether portraits, figures or landscapes are liked.

The enjoyment of music has been emphasized by the popularity of so-called "talking machines" of various kinds; these bring to the farm home a class of music that formerly was heard only when rendered by artists in large cities. The mechanical player piano is another boon to the unskilled music lover and both additions to the list of recreations serve a high purpose in country homes. They are not, however, complete substitutes for the very personal gratification of being able to actually play on the piano, violin, or other musical instrument.

Choosing the furniture of the living room of the family naturally is a life-long endeavor. Taste changes and ideals grow. Both these should be embodied in books, pictures and music, but also, they will be expressed in chairs and tables, in lamplight and firelight, in provision for the child's development, and in the elders' growth in knowledge and power.

The full use and complete enjoyment of the living center of the home will depend upon the housekeeper's management of her business. She may have to send the family washing to the town laundry and the milk to the creamery. She may have to concern herself with the hired help situation by endeavoring to bring to pass a livestock system of farming that can use married men and provide them with tenant houses, thereby taking hired men out of her home. When all is said, the farm woman still has a power of choice. She can, within certain limits, decide what to do and what to leave undone, in order to secure for herself and her family, health of body and mind, and the joy that attends right development of the mind and soul.

**The dining room.** A separate dining room entails some additional labor but it promotes a restful serenity by reason of its detachment from the scene of heavy work in the kitchen, and this, in the end, is helpful. If there is a place to save labor, there is also a place to spend it and the fitness of the spread table, when the family gathers around it, is a prime consideration in housekeeping. The spotless cloth and smoothly ironed napkins are worth their cost; the use of good china will teach children to respect good things and train them in habits of careful handling. The room and its special use being somewhat apart from the hourly routine, ought to be made to instil a sense of what family association means in promoting conversation and good cheer.

*The tea-cart*, originally intended to be an accessory of fashionable serving, has developed into a real help for the housekeeper. It can be used in carrying dishes back and forth, it may hold the coffee and cups, or it may hold the dessert and changed plates. A tea-cart stationary in the dining room may be ornamental, but is of no assistance whatever. When used habitually, it becomes a good investment in saving both time and labor.

*Cleaning silver.* It is doubtful if there is anything better for cleaning silver than the old stand-by, Spanish whiting, used dry. There are many good preparations to be had, but the best way to save labor in the care of silver is to polish often and at short intervals.

## The Bedroom—the Sleeping Center

Good taste and sanitation go hand in hand in the approved modern furnishing of a bedroom, which, being a place intended for one main use, is furnished for that purpose. The labor connected with the sleeping center of the home depends upon the choice of furniture, mattresses and bed clothing. While every one may prefer to buy from the home merchants, yet it may happen that these do not carry a full line of goods which allows a wise choice. A good mattress should last a lifetime. Indeed, a hair mattress of the best quality will last longer because it can be

FIG. 138. The bedroom should be attractive, but simple and easy to care for and keep clean

cleaned and made over indefinitely. In the selection of any article destined for long use, the housekeeper wisely buys where she has an opportunity to see and examine critically various types of the article. Then, after she knows what is in the market, she may buy whatever suits her purse. The bedstead, springs and mattress are bought with the expectation of using them for a long period, and no outlay is more inexcusable than purchasing a poor type of spring and a cheap mattress when these are to be in use for at least eight hours out of every twenty-four.

The mattress, kept clean and fresh by frequent airing, is covered by a special mat or light quilt put on underneath the sheet. Sheets made at home are more desirable because they can then be made 24 inches longer than the mattress. In this length, the lower sheet protects the mattress and the upper one folds over to protect the bed clothing from being soiled by the hands and by the breath. A short sheet is an abomination.

Many housekeepers prefer to make at home bed covers intended for warmth, using cotton batting covered with light-weight cotton cloth. These are comfortable when new, but they soon mat and when soiled, cannot be easily cleaned. The all-wool blanket has more warmth with lighter weight on account of its peculiar fiber. It is easily cleaned and with good summer care will last for years. Such a blanket is more expensive in first cost,

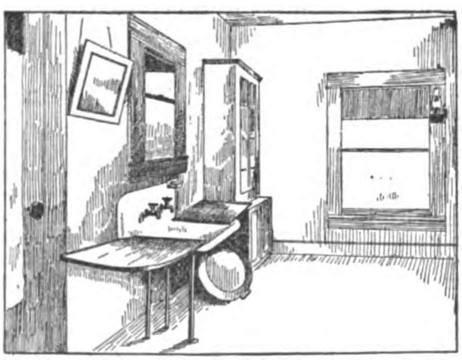


Fig. 139. A well-arranged kitchen, as far as it goes. A table near the window, a range at the right and an icebox in the foreground would permit rapid and efficient handling of meals.

yet when it can be afforded it may, in the end, prove a better investment than cotton comforts. There are those who believe that the animal fiber of the woolen blanket is more healthful than cotton fiber.

The bedstead may be of metal or wood, according as fashion or taste may determine. Either is an equal care. Both hygiene and comfort prescribe a separate bed for each person. When two persons occupy the same room, twin beds should be used.

The furniture of the room should be simple and without upholstering to catch the dust and thereby add to the labor required in its care. Likewise, the window curtains should be of wash material. This is easily laundered and will not hold dust.

The floor, whether it be of hardwood polished, or plain boards painted, should not need hard labor in its care. Rugs that can be taken out of the house for dusting may be of whatever quality one wishes and can afford, from the homemade, heavy rag rug to the oriental; the choice will make little difference in the labor required.

A bedroom furnished simply, if it has capacious closet room, may with a general cleaning once a week be kept sweet and fit without the expenditure of any great degree of labor. If there is not a bathroom in the house, then the bedroom furnishing must include some provision for water, pitcher, bowl and towels. This one item demands painstaking labor and scrupulous daily attention. In fact, this care is such a task that housekeepers generally consider a bathroom with a running water supply as one of the very greatest aids to housekeeping.

Fresh air is the efficient agent that cleans the bedroom of the foul air that has been used by the lungs during sleep, and also of the excretion from the skin, which, as an organ of excretion, is more active at night than during the day. This latter fact explains why two sheets should be used on the bed and why they should be aired every day and laundered frequently.

The labor required for the care of the bedroom is considerably reduced when it is a family habit to open the bed and the windows before leaving the room each morning, and when each person drops his own soiled garments into the clothes hamper promptly, instead of leaving them for another to pick up and put where they belong.

**A plan for buying.** The "budget" differs radically from the wife's "allowance" because it is the result of counseling together and considering the wisdom of every class of expenditures and the welfare of each member of the family before an apportionment of the expected income is made. Housekeeping with a budget is based on a plan and becomes a business with definite aims which are sure to be realized by adequate equipment and correct methods whose necessary costs are provided for.

It is ever questionable economy to buy what is not needed nor likely to be

needed in the very near future. There is, however, a wise forethought that leads to the purchase regularly of certain things to replenish the household equipment. For example, sheets and pillow cases, table cloths, napkins and towels are in constant use and wear, so it is right management regularly to replenish these stocks before the supply on hand is exhausted. Six sheets that might endure several washings and then be too worn for use would, if kept in reserve, prove very useful in the event of illness. It is, therefore, good housekeeping practice occasionally to buy new sheets and to use them while the old ones are kept in reserve for an emergency. The same is true of table linen and kitchen towels.

In buying groceries there are certain articles that are not affected by long storage, while others quickly deteriorate. Sugar in a dry room, where ants do not have access, may be kept indefinitely. Flour will improve with age for a limited period, if kept in a well-ventilated room. Soap improves on being kept. Flavoring extracts, baking powder and similar goods are much cheaper in the larger containers, while breakfast foods, cereals and roasted coffee must be bought in small quantities.

Buying in a good market where a large stock of goods may be examined is sometimes very advantageous. In buying articles such as kitchen range or cooking utensils, which are all the time being improved, new types should be seen and examined. Often a merchant engages to handle but one make or style of a manufactured article, and this of course limits the choice. The insistence of a traveling agent may prove a trap for the unwary, but for one who knows, and who has a plan for buying, this source may in some cases prove a convenience. Meritorious articles are sometimes introduced in this way because local dealers are under contract to handle something else.

**Family habits.** The ancient rule, "a place for everything and everything in its place," sounds easy, but, in fact, is extremely difficult to put into operation as a plan of every-day action. Only the very modern houses are built to provide a place for everything. The average farm house is the despair of a housekeeper when she attempts to enforce an orderly system. If there is no closet or corner for the coats, hats and rubbers which the children have worn to school, it is to be expected that inevitably chairs and tables will be used. Family habits, to be agreeable, must have a working chance, and it would, when possible, be better to surrender a room to miscellaneous and unclassified uses than to have the entire house cluttered with miscellaneous and unclassified articles belonging to the several members of the family.

When a child does some one thing for the family meals, such as bringing and pouring the water, slicing the bread or carrying out the plates—some one thing done regularly and in the right way—there is established the dependable habit of helpfulness. Even when the task is no more than sweeping a porch, winding a clock, or feeding the cat and dog, it nevertheless contributes to reducing the sum of required labor in housekeeping. Habits that do not require labor but which demand thoughtfulness are strongly contributory to smooth housekeeping. "I forgot" is one of the most exasperatingly unkind hindrances to comfortable housekeeping.

**The importance of relaxation and change.** The foremost duty of every woman who is the mother head of a family is to build up and maintain her own health of body and mind. This is not selfishness, but rather preparation for service, because it is impossible for any one to do her best for others until she has first done the best possible for herself.

The farm woman, perhaps more than the town woman, is dependent on her own lead. In the country, there is a lack of the agencies which promote

amusement, recreation and popular instruction; in the country very little enjoyment outside the home is furnished ready-made and to be had for a price, as it is in town. These considerations put upon the farm woman an obligation to create whatever forms of recreation will promote her own welfare, the welfare of her own family and the welfare of her community. The latter is important for it is apparent to every thoughtful observer that the community influences strongly the child in the home.

**Change** through going away from home occasionally or periodically is a duty, whether one comes back to-day or not until next week. Change whets the edge of appreciation and understanding, and renews interest in the routine of every-day life which otherwise might grow dull and monotonous to a paralyzing degree; change renews the strength of the will, and renders the mind more elastic and capable of considering new ideas. Change itself brings relaxation.

FIG. 140. The farm woman's life demands frequent change. She should "cut loose" now and then.

Association with others is the greatest refreshment to the soul, as many groups of women have found. *The woman's club*, as it has been developed of late years, is distinctively wholesome and so broadly inclusive in its interests that it may well fill a large place in the life of a farm woman. Whenever a group of women with neighborly spirit organize for social and educational purpose, they secure for themselves a degree of enjoyment and inspiration quite out of proportion to what it costs. There are many societies organized in the churches and by national associations for particular propaganda like missionary work, temperance, suffrage and so on, and the farm woman wishes to keep in touch with these fundamental interests.

The woman's club, though, differs wholly from these. It brings into association the women of the several churches and associations, it breaks down lines of division, and unites all in the paramount interests of their own community, their own children, their own development. Personal effort changes to mutual effort.

The *home economics club* is a popular type in rural communities. There the farm woman finds familiar interests that lie in the field of her own experience, and when discussed by the group, these afford a very personal stimulus and may indicate lines for coöperation of the most inspiring nature. While membership in the club may increase her work and the demand upon her time, it is, nevertheless, a means of relaxation because it is a change. Moreover, it reacts upon her necessary routine at home; it gives to her the enjoyment that comes through a better understanding of the why and how of home making.

An established agency that may furnish relaxation for the farm woman if regularly used, is the *public library* in town. She may have books at home, and certainly she will not find time to read in the library, but the large list of magazines kept there will provide an hour of real pleasure. If she merely turns their pages and looks at the pictures, she will gain knowledge of current world affairs and many suggestions for topics of conversation at home. And, too, in every up-to-date library she will learn what it is doing to serve children. This will enable her to coöperate intelligently at home, and thereby to enlarge the home life to include new forms of relaxation.

Another agency recently established is the *county farm agent*. The Federal Government is endeavoring, in coöperation with the several states, to place in every community the services of a farm adviser and a home adviser. By seeking, directing, and using these local agencies it becomes possible to develop forms of coöperation among neighbors and to organize groups of people that can create conditions such as will make harmless amusement and innocent recreation accessible to all. These agencies, however, are barren until used. By seeking and using them, the farm woman may secure a good form of relaxation that comes from a changed interest; she may find an outlet for whatever ability she has that has been suppressed, an outlet for aspirations that hitherto have been repressed.

**Developing and maintaining a hobby** is not only a sure road to relaxation but, in the case of farm women, it is a safe one because not likely to become the main concern. Rather, will it remain an incidental interest. When Secretary Houston of the U. S. Department of Agriculture asked 22,000 farm women for a statement of their social, labor, economic and educational needs, the published replies indicated strongly two main lines of thought. First, there was expressed a desire for better social and educational opportunities for farm children; second, a wider opportunity to gratify one's own love of the beautiful in the home and its surroundings. In harmony with

the latter, the cultivation of flowers and shrubs becomes a useful hobby, and by being mainly an outdoor activity, it contributes to both good health and good spirits. The tired, melancholy, discouraged outlook and the fretful, nagging temper disappear when one knows the joy of the successful tending of flowers and shrubs. One woman interested in the germination of flower seeds began growing peonies—the "piny" of grandmother's day. She eventually produced flowers of amazing variety and some of great beauty. At length she devoted 10 acres to her plantation, thereby turning the venture that began as a hobby into a commercial enterprise; this illustrates not business opportunity but the boundless opportunity for developing a living interest in the little things that are at hand and all about us, the things that offer relaxation from the main business of daily housekeeping.

Another woman finds real recreation in the care and breeding of a flock of poultry and has two interesting strings to her bow. First, she has the breeder's satisfaction in controlling the conditions that create life, in seeing chicks develop into hens with the conformation that determines function; she sees the color and marking of a feather become what was decreed for it in her choice of breed and mating; she reads the poultry journal with zest, and attends the poultry show with eager interest. Second, she sells eggs for a price! That egg production, as a specialty and an outdoor activity, is well intrenched in the favor of farm women, is demonstrated by a record of eggs sold from farms (not commercial plants) in one year for more than $300,000,000.

The farm woman can contribute three things to her community's welfare, namely, her personality, her knowledge and her home. When she contributes her home she very probably will get back something that is of inestimable value, something that is in fact a wholesome relaxation from her usual housekeeping. The recreations of young people need to be enlarged and centered in the home; chorus singing, little dramatics and other harmless expressions of social life are encouraged by the woman who offers her home, generously and ungrudgingly, to the young people. Too often the elders spoil the fun by assuming all the labor of preparation for company. Party refreshments that are a burden to one woman, are a lark when made ready by half a dozen boys and girls; decorations that would tire one housekeeper beyond endurance, are arranged and become sport for four or more young people.

The woman who contributes her home with an atmosphere of good cheer, secures in return a touch of the spirit of youth. For her, whatever is unlovely and a burden falls away; she is a new creature in her faith and in her belief that all is well with the world.

## Hobbies for the Farm Woman

(*By* Mrs. Helen Johnson Keyes)

To be contented, every farm woman should have a hobby. There is leisure time even on a farm, and its happy employment puts new strength into a woman's heart to overflow even her working hours, filling them with content, and bathing all the family life in sunshine. Every one acknowledges that it is our duty to be good, faithful workers; more and more the truth is being appreciated that it is our duty also to be good, diligent players. Of course, one can play and find recreation without a hobby, but unless one has companionship, such play and diversions are often unsatisfying. A hobby, however, *is* a companion, and in playing with it we shall not feel alone even though the others of the family are absent.

### The Joy of a Hobby

The farm home is fortunate which has as a housewife a woman who loves to make things. There are many hobbies for her to choose and so long as her fingers are busy on some work of skill she will be happy. Fancy work, basketry, china painting, photography, even carpentry, upholstering, or the refinishing of old furniture which she finds dusty and damaged in the attic and can make attractive for the home, are all within her powers.

Women riding such hobbies will find their pleasure greatly increased if they do not depend on manual skill alone, but acquire also an artistic knowledge of their materials and

methods. They must train their eyes so that they can combine colors pleasantly, and learn to choose those designs and shapes which will serve their purposes most simply and well. The best of the women's magazines give splendid education along these lines.

FIG. 141. Flowers provide a hobby that is always enjoyable and that can often be made profitable.

**Music.** The hobbyist who likes to make things will prefer to play and sing rather than merely to listen to music. The woman who thus enjoys music has a refuge from loneliness, fatigue, and depression, even though her performance is not skilled. Her pleasure in playing will be greatly increased if she adds to the delight of creating beautiful sounds a little knowledge of how music is composed—how, for instance, a composition is based on a little tune, a sequence of notes, called a theme or motive, which is developed through different keys, and threads its way in many strange disguises through many hiding places, finally to be heard again. It is fascinating to follow this theme, and to the truly musical ear and soul, it may tell in its wanderings a deep story of the human heart. There are two delightful books which will help any music-maker who wants to go as deeply into her subject as this, namely, "How to Listen to Music," by Henry Edward Krehbiel, and "Appreciation of Music," by Thomas Whitney Surette and Daniel Gregory Mason.

The women who really enjoy studying and experimenting to increase their abilities are the Marthas of the farm. Without them many of the activities of the United States Department of Agriculture, many of the projects of the Smith-Lever Bill, would fall on barren soil. They are the yeast in the farm home. Their hobby is *improvement*, and it may be along almost any practical line. To the outsider, their diversions may seem so much like their work as to be scarcely refreshing, but they never become drudges because their hobbies put enthusiasm into all they do. Whether they choose poultry, bees, gardens, house-improvement, church work, or club work, they will find a valuable collection of bulletins theirs for the asking, or for the asking plus a few cents. For full lists and instructions they should write to the United States Department of Agriculture, the United States Bureau of Education, the United States Public Health Service, and the Children's Bureau, all in Washington, D. C., and to their own state agricultural colleges.

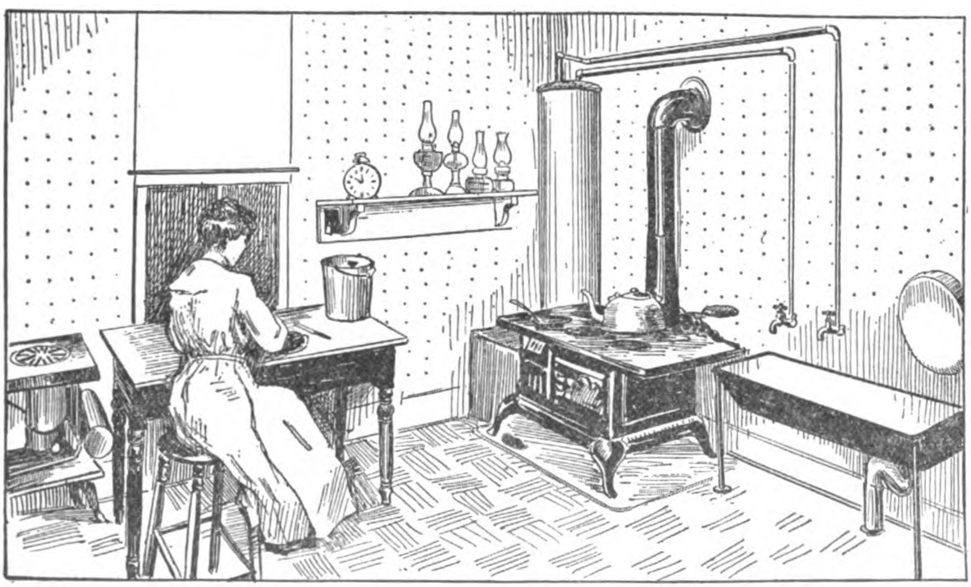


FIG. 142. There is no more useful hobby than that of striving for greatest efficiency with the least effort. The kitchen is a great place for its practice

### Hobbies as Sources of Pin Money

It is often possible to make a hobby the source of a small income, particularly if it has to do with making or doing things. Literary and musical hobbies are not easily turned into money on the farm.

Whatever pin-money labor is chosen, two things are necessary to its success: (1) A careful study of the market to see what things are wanted and where they can be sold to the greatest advantage; (2) satisfying that market by making or raising a superior quality of whatever is to be supplied to it.

The market may lie near home or it may lie in a city some distance away; it may be most profitable to sell to a dealer, or to build up a trade directly with consumers. These are questions which depend on local conditions and for which every woman should find the correct answer before starting her pin-money drive.

In any case the work should include advertising in newspapers and the use of notices of what is offered tacked up in post offices, etc. Every article sent out should be of high quality and attractive appearance. All should be standardized and thoroughly dependable from top to bottom and from month to month. These features will prove the best advertising. The pin-money earner should keep her accounts carefully, entering in a ledger her expenses, receipts, and gross and net profits. Accurate bookkeeping on the American farm has frequently revealed the surprising fact that hard work was being done at actual money loss.

In some rural communities there is often a good sale for tasteful fancy work. Plain sewing of a serviceable kind, such as aprons, children's rompers and overalls, and bags of various sorts, also find buyers. Occasionally it is possible to do the weekly mending for families spending vacations in the neighborhood. If a woman has a camera she frequently pleases people with pretty views of the countryside which may be sold as pictures or worked into fancy articles, such as blotters, calendars, or writing tablets.

Places called Women's Exchanges exist in many small towns, as well as the larger cities, where fancy work, food products, etc., are offered for sale on commission. If not sold within a reasonable length of time, it is returned to the maker without charge. A membership fee in the exchange, however, is payable by every one placing work there.

Editors of farm papers are glad to buy clear photographs of curiosities in scenery, of fine plants, stock, convenient devices, and unusual and practical buildings or parts of buildings. The pictures submitted must be very clear and sharp, and have a shiny finish, and they should be accompanied by a description of what they are intended to show.

The amount of money which can be made out of the so-called small industries of the farm—fruits, vegetables, flowers, pickles, preserves, honey—has been one of the surprises revealed by accurate bookkeeping. While a wheat farmer, for instance, may have been laboring for a net return of, say, $8.00 an acre, his wife may have been raising a few onions, cucumbers, and strawberries at a profit of $100 an acre! Or perhaps she has been making good the losses from extensive grain farming with the profits from her flock of poultry. Every one enjoys eating; indeed, every one must eat. Foodstuffs of superior excellence will always find a market; if they do not require the use of machinery, and if they can be sold directly to the consumer at retail prices, the profits from them should be considerable. Oftentimes their cultivation is within the range of ability of the farm woman. Fruits, vegetables, flowers, plants, pickles, honey, jams and jellies, poultry products, medicinal herbs, parcel post dinners ready prepared—these are only a few suggestions towards the development of which farm women may direct their ingenuity in their spare moments.

## B. FEEDING THE FARM FAMILY

*By* BAB BELL, *in charge of the Home Economics Extension Work of the Missouri State Board of Agriculture. Born and reared on a Ralls County (Missouri) farm, she taught a rural school for a year, and later studied Education—especially in Home Economics—at the State University, graduating in 1911. She organized the Department of Home Economics of the Hannibal High School the same year, remaining there as teacher for 2 years. From 1913 to 1915 she was Institute lecturer with the State Board, before advancing to her present position.*—EDITOR.

PURCHASING food supplies, and planning and preparing three meals a day in an economical manner is a problem at any time, and a serious one indeed when food is very costly. The problem of the woman on the farm differs from that of her city sister, inasmuch as the country woman is vitally concerned with the production of food as well as its use, while the city woman is directly concerned only with the purchasing.

The garden and orchard, the poultry yard, the dairy and the hog lot, are

all sources of food for the farm woman's pantry and storeroom. So in order to feed her family in the most economical and efficient manner, she should know how to make the best use of fruits and vegetables, how to care for meats, and how to look after poultry and dairy products.

## Planning Meals

There is a popular belief that the farmer's family has better food and more of it than any other class of people. To be sure it has a better opportunity to have the right kind of food, since eggs, milk, fruits, and vegetables are usually plentiful, and these are the foods which should form an important part of our diet. It is true that the farm table usually sets forth abundant meals *but* not always are these meals well planned. However, the time has passed for farmers' wives to serve 3 or 4 kinds of meat, as many varieties of vegetables, and 2 or 3 desserts. We are beginning to realize the amount of time and energy expended in preparing these overloaded tables, the cost of these expensive meals, and, last but not least, the effect of overeating on the health.

Since women are in a large measure responsible for the health of their families, it naturally follows that they should know something of actual values of our standard foods. When women realize that balanced meals are most easily prepared, cost less, and are sure to result in better health, fewer families will be eating unplanned or, as they are called, unbalanced rations.

Many women have the idea that the scientific planning of meals means long, hard study. As a matter of fact, any average woman can learn the general underlying principles in a short time, whether she knows the scientific terms or not. The three principles have to do with:

1. **The functions of food which are:** (a) to furnish energy; (b) to build tissue; (c) to regulate body processes.

2. **The classification of foods into:** (a) *Proteins*, used to build tissue and to furnish energy; found in milk, cheese, eggs, lean meats, fish, beans, peas, lentils, cereals and nuts. (b) *Carbohydrates*, used to furnish energy; include all starches and sugars; found in cereals, such as oats, wheat, rye, corn, rice, etc., starchy vegetables such as potatoes and corn, and in sugars and syrups. (c) *Fats*, used to furnish energy; found in butter, cream, fat meat, lard, and oils, such as olive or cottonseed. (d) *Mineral salts*, which build bony tissue and aid body processes by furnishing materials necessary for digestion, circulation, etc.; found in fruits, vegetables and whole cereals. (e) *Water*, regulates body processes by: (1) Regulating body temperature; (2) dissolving the food for digestion; (3) carrying the food; (4) removing waste from the body.

3. **The amount of food necessary.** Although *protein* serves as an energy producer, its principal effect is as a tissue builder, and the amount used should be limited to 10 to 15 per cent of the total amount of food. Surplus protein overworks the body and is liable to cause intestinal putrefaction. *Sugar* furnishes quick energy, but ferments easily in the stomach. Limit the amount of sugar, therefore, to 10 per cent of the total food. *Starch*

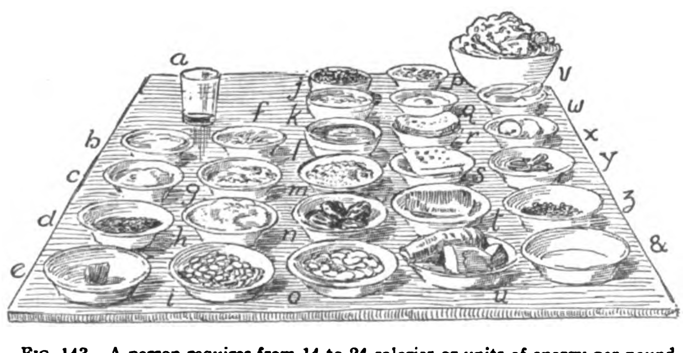


FIG. 143. A person requires from 14 to 24 calories or units of energy per pound of body weight. Here are portions of common food materials each representing 100 such calories: *a* olive oil; *b* gelatin; *c* corn-meal; *d* cocoa; *e* chocolate; *f* macaroni; *g* rolled oats; *h* cream of wheat; *i* navy beans; *j* spinach; *k* rhubarb; *l* cranberries; *m* stewed apples; *n* prunes; *o* lima beans; *p* shredded codfish; *q* egg; *r* bread; *s* crackers; *t* shredded wheat; *u* carrots; *v* lettuce; *w* banana; *x* onions; *y* dates; *z* raisins; & sugar. (Cornell Reading Course.)

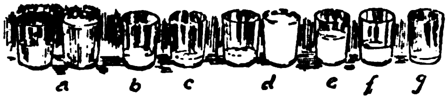



FIG. 144. 100-calorie portions of milk products: *a* whey; *b* evaporated milk; *c* condensed milk (sweetened); *d* skimmilk; *e* whole milk; *f* 18-per cent cream; *g* 40-per cent cream. (Cornell Reading Course.)

makes up 50 to 55 per cent of the total food, and is the best form of energy for the body. *Fat* makes up 30 per cent of the total food; too much retards digestion and may produce nausea. *Mineral salts* should be provided for at every meal by including plenty of fruits and vegetables. Most people do not drink enough *water*. It is believed that plenty of water aids materially in digestion and helps in avoiding constipation.

In all well-selected meals a certain amount of indigestible bulk is necessary. Like livestock, we need "roughage." This may be obtained from *cellulose*, which is the woody framework of vegetables and fruits. Cabbage, celery, and lettuce are good "roughage" foods. Fruits and vegetables and milk furnish alkaline-forming elements which counteract the acid-forming foods, such as meat, eggs and cereals.

With this knowledge at hand, it is a simple matter for the housewife to plan well-selected meals by using the following suggestions:

1. Make a study of the principal foods and their value.
2. See that all 5 of the principal food classes are included in the right proportions at every meal; do not duplicate by using similar foods such as sweet and Irish potatoes, corn and corn bread, or a meat and meat salad.
3. See that the meal planned meets the needs of every member of the family. Children need plenty of milk, vegetables, cereals, and fruit; very little meat and sugar; and principally mild-flavored food. Adults engaged in active outdoor work require plenty of energy-producing food and can make use of coarser material than can people in inactive life. The aged require less protein, and an abundance of fruit and vegetables.
4. Understand thoroughly the correct method of cooking each food product, which conserves all the food value.

A skeleton outline, which includes the groups necessary for the daily meals, and examples of each may be developed, as follows:

*Breakfast.* Fruit (fresh, stewed or canned); cereal (oatmeal, cream and sugar); one hot dish (light meat or eggs); bread, butter; beverage (milk or coffee).

*Lunch or supper.* One principal dish (such as cold sliced meat, baked beans, or macaroni and cheese); one light vegetable (tomatoes) or vegetable salad; bread, butter; fruit or some type of simple dessert (apple sauce); beverage (milk).

**Dinner.** Soup or fruit; meat (cold sliced ham) or meat substitute; one starchy vegetable (potatoes); one light vegetable (green beans) or salad; bread, butter; simple dessert (fruit gelatin and cream); beverage (tea or milk).

## Suggestions about Substitutes

**Substitutes for meats.** Many people eat too much meat. Health and economy both demand that we use the meat substitutes whenever possible. The composition of the following articles makes them well adapted for meat substitutes:

*Milk*, which is a real food and should be used as such. Skimmilk is a cheap source of protein supplied in a very digestible form. There is really no good substitute for milk, especially in the diet of children. It contains mineral salts and certain growth-promoting substances which are very valuable to children. Milk cannot be used weight for weight with other meat substitutes on account of the large amount of water it contains.

*Eggs.* Eggs should be more used in place of meat since they are easily digested, easy to prepare and very valuable for their growth-promoting substances. Too often meat and eggs are served in one meal. This is unnecessary. Vary the ways of cooking eggs instead of serving them in one or two ways repeatedly. Also serve in combinations with other foods as custards, cornbreads, etc. Like milk, eggs have no good substitutes. The number used in baking or in the making of custards may be decreased by the use of cornstarch and baking powder, bearing in mind that the food value of the dish is changed.

*Cheese* is a good substitute for meat since it is high in protein and fat. It is a concentrated food and must be chewed slowly and thoroughly. The method of preparation is important. When served in combination with other foods, it is more digestible. If cheese is heated to a high temperature as is often done in preparing baked dishes, such as rice and cheese, and macaroni and cheese, it becomes tough, leathery and indigestible. Serve cheese as the main dish rather than as a supplement.


FIG. 145. A day's food for a family of five: *a* milk (2 qts.); *b* beef (1 lb.); *c* eggs (2); *d* cabbage, *e* apples, *f* potatoes (total of the three, 4 lbs.); *g* bread (1½ lbs.); *h* sugar, *i* rolled oats (¼ lb.); *j* flour (1 lb.); *k* rice (½ lb.); *l* butter or other fat (¾ lb.). (Farmers' Bulletin 808.)

Cottage cheese is valuable as a source of protein but contains little fat. American cheese may be substituted for the expensive imported cheeses which are valued principally for their flavor.

*Nuts* make excellent meat substitutes since they, too, have both protein and fat. Peanuts, almonds, and pecans are especially high in protein. Nuts are concentrated food like cheese and should be finely divided and served in small quantities and in combination with other foods; for example, nut bread, cookies and nut rice loaf.

*Beans and peas* (including soy-beans and cowpeas) may be used in place of meat. Long soaking and long, slow cooking should be used in preparing legumes for table use.

**Fat substitutes.** Where the price of *butter* is prohibitive, there is no reason why *oleomargarine* should not be substituted. Where the feeding of children is concerned, care must be used in making this substitution, since butter contains substances which play an important part in children's growth and which oleomargarine, although a wholesome product, does not contain. This objection may be overcome by giving whole milk to the children.

When *lard* is high in price, it is necessary to find a substitute. Suet is comparatively cheap, but since it is of a hard consistency it is not used extensively in cooking. If 1 part of oil (cottonseed oil, corn oil, etc.) be added to 2 parts of suet, a good and satisfactory compound may be had at a reasonable cost. In summer, suet may be added to lard in small amounts to give a harder fat. In salad dressing, cottonseed oil may be substituted for olive oil, the food value being the same. If the flavor of olive oil is desired, use a small portion of olive oil with a large portion of the other oil. Buy all oils in quart or gallon receptacles to reduce their cost.

**Potato substitutes.** This vegetable is one of our staple products. When there is a shortage of this crop making the cost prohibitive, rice, hominy and macaroni may be substituted. Potatoes yield alkaline products in the body while cereals yield an acid product. Therefore, use other vegetables in abundance to counteract the effects when substituting these cereals for potatoes.

**Breakfast foods.** Where the cost of fuel is not to be considered, the home-cooked breakfast foods will furnish more nutritive value for the money than the ready to serve forms. Whole cereals furnish more food value than the milled.

**Breadstuffs.** Whole-wheat or graham flour can be substituted for white flour with advantage since both include a large portion of mineral which is omitted in the white flour. Cottonseed meal may be substituted in part for white flour but its content of protein is so high that it should be substituted for only one third the amount of white flour. Shorts also may be substituted for a part of the white flour in bread making, and cornmeal may be used alone or in combination with flour. Cornmeal contains a large proportion of protein which is incomplete but this lack is supplied if milk or eggs are used with it.

**Fruits and vegetables** are necessary to the diet and should be included frequently. In winter dried or canned fruits are cheaper than fresh products, and may usually be substituted for them. There is a tendency to cut down fruits and vegetables in the diet as their prices go up. This is a mistake; they are just as necessary as any other class of food.

## The Preparation of Foods

The preparation of foods is rarely given proper consideration. There is a right and wrong way to prepare each food, yet we seldom see one housewife preparing all of them in the right manner. To be sure, this is the day of specialization, yet when women prepare 3 meals per day 365 days in a year, every kind of food is usually cooked. Just as far as possible all should be well prepared. It is as easy and cheap to make well-flavored, healthful coffee as poor-flavored, injurious coffee. In like manner, light, flaky biscuits require no more in their preparation than do heavy, soggy ones.

Each housewife should therefore endeavor to acquire skill in the various lines of cookery, rather than make, or in addition to making, a specialty of one. Most American families have pampered appetites due to eating rich and highly flavored foods. Our ideal in food preparation should be plain, wholesome, palatable foods prepared with care and skill. The following subdivisions in food preparation are discussed in the following pages:

It will be noted that very few recipes are given. Housewives should learn the general proportions and make their own variations, and so be independent of the popular cook book which gives recipes only. For example, one good recipe for butter cakes may be used as a foundation for all other cakes in that class, and the memory does not have to be taxed to keep in mind the numerous cake recipes so much in vogue.

### Bread Making

Many women find bread making a hard task. Yet if a few essential points are understood, bread making is easy and success is assured. The usual ingredients entering into bread are flour, yeast, salt, fat, liquid and sugar. The *flour* in most common use is a combination of the soft- and hard-wheat flours, but whole wheat, shorts, cornmeal and cottonseed meal, soy-bean meal, rye, barley, buckwheat, rolled oats, rice and potatoes may be used as partial substitutes. Either compressed *yeast*, dry yeast cake, or starter yeast may be used. Yeast consists of masses of tiny, colorless, oval-shaped plants which cannot be seen with the naked eye. Proper food, moisture and the right temperature are required for their growth. *Salt* is used to improve the flavor; one teaspoonful to a loaf is the correct amount, and more will prevent the growth of the yeast plants. *Fat* is added to improve the flavor and to make the crumb more tender, but it is not a necessary ingredient. For *liquid* water, milk, half water and half milk, potato water or whey may be used. *Sugar* improves the flavor of bread and also hastens the growth of the yeast plants; too much toughens the bread; use only one tablespoonful to a loaf.

*Proportions for one loaf of bread*

| | |
|---|---|
| 1 cup liquid | 1 tablespoon fat |
| ¼ dry yeast cake or | 1 tablespoon sugar |
| ¼ cup liquid yeast or | 1 teaspoon salt |
| ¼ cake compressed yeast | 3 to 4 cups flour. |

There are two processes for making bread, as follows:

1. **Long-process** (sponge bread). (1) Scald the liquid. (2) Soften yeast (if in cake form) in ½ cup lukewarm water. (3) Add liquid to bowl containing sugar, salt and fat. (4) Cool and add yeast. (5) Add enough flour to make a batter. (6) Beat thoroughly. (7) Cover and let stand until light (at a temperature of 79 degrees F. or 26 degrees C.); let stand over night if desired. (8) Add remainder of flour and knead. (9) Place in clean bowl, cover and let rise to double its bulk. (10) Knead into loaves and place in pans. Let rise to double its bulk. (11) Bake 45 to 60 minutes at a temperature of 420 degrees F. or 220 degrees C., lowering the temperature the last few minutes.

FIG. 146. Complete outfit for successful bread making.

2. **Short-process.** This is the same as the long method, except that all of the flour is added at once. Compressed yeast makes excellent short-process bread. Dry yeast cannot be used as the yeast plants must be in active growing condition.

The bread mixer is a great labor saver. Bread mixed and worked in this machine has a good texture and flavor, and the labor involved is much less. It is necessary to use the proper proportions of flour and liquid. The bread ingredients are added to the mixer in exactly the same manner as given in the directions for mixing the long-process bread. A sponge or straight dough bread may be made in the mixer depending upon the kind of yeast used. In adding the flour to make the dough, the crank is turned to mix it in thoroughly. Flour should be added until the dough does not stick to the sides of the mixer. Turn the crank 3 minutes after the ingredients are all in, then cover and set aside to rise. After rising, turn until the dough forms in a ball about the kneading rod. Remove the dough from the mixer and place in bread pans to rise.

*Whole-wheat Bread*

| | |
|---|---|
| 1¼ cups liquid | 3 cups whole wheat flour or |
| 3 tablespoons brown sugar | 2 cups whole wheat flour and |
| 1¼ teaspoons salt | 1 cup white flour |
| 1 pound fat | ½ yeast cake |

Heat the liquid, together with sugar, fat and salt. When lukewarm, add the yeast and flour; mix well and let it double in volume. Knead, put in pan, let rise to double its bulk and bake.

*Shorts Bread*

| | |
|---|---|
| 1 cup liquid (milk or water) | ½ to ¼ cake of yeast |
| 1 tablespoon fat | 2 cups shorts |
| 1 tablespoon sugar | 1 cup white flour |
| | 1 teaspoon salt |

Make a sponge, using the white flour. When this is light, stir in shorts, and proceed in the usual manner. Cottonseed meal bread may be made by using the above proportions, and substituting 1 cup of cottonseed meal and 2 cups of white flour for the materials given.

*Cornmeal and Wheat Bread*

| | |
|---|---|
| 1½ cups liquid (milk or water) | 1 tablespoon fat |
| ½ cake compressed yeast | 1 cup cornmeal |
| 1½ teaspoons salt | 2 cups wheat flour |
| | 1 teaspoon sugar |

Soften the yeast in a quarter of a cup of the water. Cook the remaining 1½ cups of water, the cornmeal, salt, sugar, and fat for 20 minutes in a double boiler. Cool and add the flour and yeast. Let rise until it doubles its bulk. Make into a loaf, let rise again, and bake.

## Biscuit Making and Leavening Agents

Every good housewife prides herself on having her bread and cakes light. The substances she uses to obtain this result are called leavening agents, and may be divided into three general types, namely, air, steam and carbon dioxide gas.

**Air and steam.** Air is introduced into doughs by beating or by adding to the dough beaten egg whites, in which a great deal of air has become entangled. Beaten biscuit, sponge cake, and omelet are made light by this process. Hot air has greater volume than cold air. When the material into which air has been introduced is placed in the hot oven, the small air cells increase in size, stretching the gluten in the flour or the albumen of the egg, and making the substance rise. As the dough becomes heated in the oven, the liquid in it is converted into steam. Steam has a very great power of expansion and stretches the elastic dough. "Popovers" and puffed pastry are good examples of the effect of this type of leavening agent.

**Yeast.** The earliest known leavening agent was yeast. While this name was not applied to it in the early ages, nor the process by which flour mixtures were made light understood as it is to-day, the method was similar. Bakers of the early ages and women in the home knew that dough or batter would undergo certain changes if left standing, and that a different kind of loaf would be produced. We know now that the reason why the flour and water mixture became light was because certain small organisms which are everywhere present in the air, grew in the mixture and lifted it as they gave off a gas called carbon dioxide. As the action of the ordinary yeast requires several hours, a more rapid leavening agent is often desired.

**Sour milk and baking soda.** Carbon dioxide gas is set free when sour milk and baking soda are combined. The scientific name for the substance that makes the milk sour is lactic acid, and the soda appears in chemistry books as bicarbonate of soda. (See Chapter 17.) Another practice familiar to many housewives is the use of soda and sorghum molasses which contains an acid.

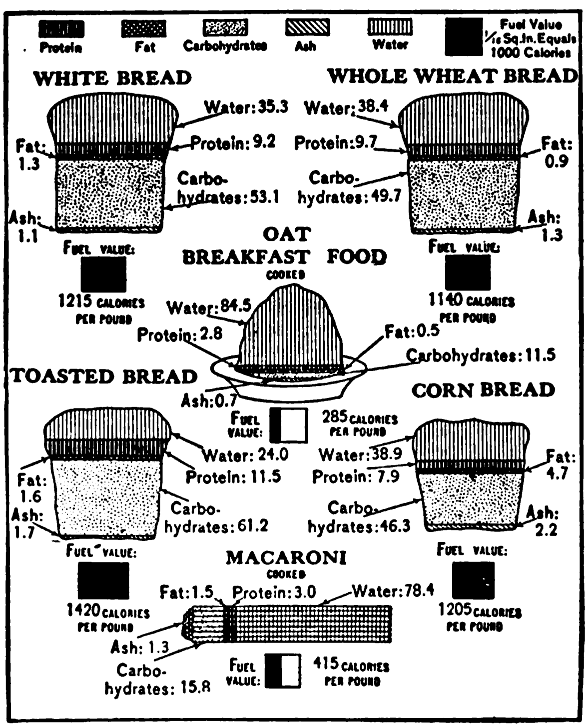



FIG. 147. Composition and fuel (energy) value in calories of some cereal products. This and similar charts on succeeding pages, prepared by C. F. Langworthy, Office of Experiment Stations, U. S. Department of Agriculture.

**Baking powders.** While baking powder is to-day the most generally used leavening agent in the household, its discovery is comparatively recent. All baking powders have certain points in common: (1) They contain bicarbonate of soda and an acid in powder form, and upon the kind of acid used, depends the variety of baking powder; (2) they all contain a filling of starch which keeps the mixture dry; (3) carbon dioxide gas is given off from all the powders when they are moistened.

With reference to the acid principle they contain, baking powders are classed as tartrate, phosphate and alum powders. The acid ingredients used in tartrate powders are cream of tartar and tartaric acid; the former is found in ripe grapes, and the latter is derived from it. Cream of tartar is soluble in hot water but only slightly so in cold, hence dough containing tartrate baking powders can be kept for a short time before baking. The source of the acid ingredient used in phosphate pow-

ders is ground bone or phosphate rock. The carbon dioxide gas escapes immediately after this powder is moistened, hence batters or doughs containing it must be hurried into the oven. The acid of alum powders is made from a kind of clay called alum ore. It is cheap, hence the powder is cheap. Many authorities hold that the residue left in the system by alum baking powders is harmful.

Some women prefer to make their own baking powders. To do so, carefully measure and mix 4½ pounds of cream of tartar, 2 pounds of soda and 2 pounds of starch.

Biscuit making. In making biscuits, the following ingredients are necessary: flour, liquid, fat, some rising agent, and salt. Pastry flour is best for biscuit making; bread flour contains more gluten and makes a tougher biscuit; the substitution of 2 tablespoons of cornstarch to each cup of bread flour used will make a good pastry flour. The liquid used may be sour milk, sweet milk, or water; the amount varies with the flour; hard-wheat, graham and whole-wheat flours require more liquid than soft-wheat flour; however, one third of a cup of liquid to 1 cup of flour is approximately correct. For fat, butter, lard or any of their substitutes may be used. Lard gives whiter biscuits than butter. One to two level tablespoons of fat for every cup of flour is the usual proportion. If sweet milk or water is used, baking powder is the rising agent, the usual proportions being 2 level teaspoons to 1 cup of flour; however, if desired, less baking powder may be added. When buttermilk is the liquid, add for each pint, 1 level teaspoon of soda. While these definite proportions are given, the housewife must vary the amount of soda according to the sourness of the milk.

*Baking Powder Biscuits*

| | |
|---|---|
| 3 cups flour | 1 cup water or sweet milk |
| 4 to 6 teaspoons baking powder | 1 teaspoon salt |
| | 1 to 2 tablepoons fat |

Sift flour, salt and baking powder into a mixing bowl. (Never put the leavening agent into the liquid.) Add the fat (cold) and mix with spoon or spatula. If the hand is used, the fat may be melted and produce less flaky biscuits. Add the liquid, mixing as little as possible or gluten will develop, making tough biscuits. While the biscuits should be mixed just enough to handle, yet care must be taken not to have them too moist, as a hard crust will then form on the top and bottom. Roll to half an inch in thickness, cut to a small size and bake in a very hot oven.

Biscuits, if made properly, are as digestible as bread, although there is a popular belief to the contrary. Bread or biscuits, if soggy, will be hard to digest, since a doughy mass is formed which the digestive juices cannot easily penetrate. The dryness of toast and stale bread enables them to become more easily moistened and mixed with the digestive juices.

Biscuits should be small, light and flaky. Large biscuits are more liable to be soggy than small biscuits. The crust should be a light brown. This brown part is *dextrin*, and is formed when dry heat is applied to starch. It is more easily digested than starch, and gives toast its highly digestible quality. Small biscuits with a good crust have a good proportion of it.

## Meat Cookery

Pork has been the principal meat used in the country home, but beef, which is more easily digested, is growing in favor. Most women are familiar with the different cuts of pork, but how many know the different cuts of beef and how to cook each to the best advantage? Often we find women buying high-priced meat and discarding all the cheaper cuts. This is a great mistake, as the cost of living can be reduced by making use of the cheaper cuts.

With a thorough understanding of the structure of meats, their cooking should be

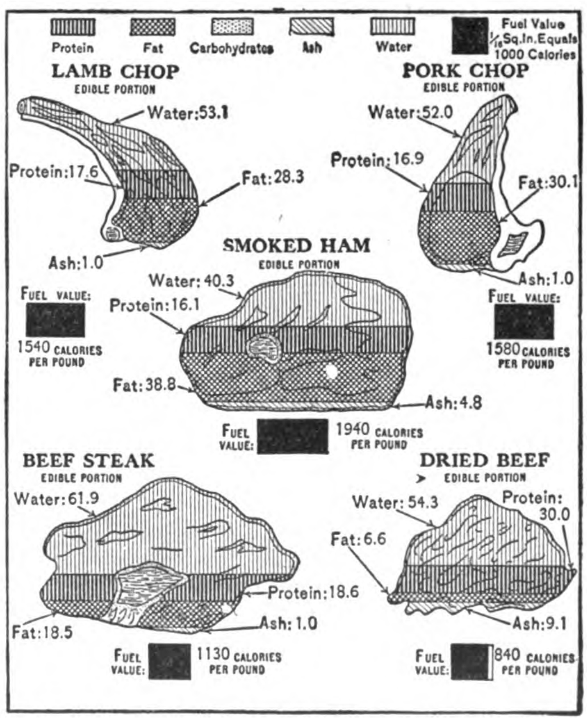



FIG. 148. Composition and fuel value of meats.

an easy problem. If a piece of boiled meat is examined it will be found to consist of long, stringy fibers. If these fibers could be seen under the microscope they would be found to be made up of tubes (muscle fibers) containing proteins, water, salts and extractives. To the extractives are due the characteristic flavors of meats; when they are removed, as when meat has been boiled a long time, the meat is tasteless. The flesh of young animals is not as rich in extractives as that of full-grown animals, so some add sauces and acids to give these meats a flavor. The fibers are held together by connective tissue made up in part of fat cells.

Meat is cooked to (1) develop flavor, (2) improve the appearance, (3) soften connective tissue, and (4) kill any living organisms that might produce disease. Tender and tough cuts of meat should not be cooked in the same way; yet we find many women buying high-priced, tender meat and spoiling it by cooking it as they would and should cook tough meat. Broiling and roasting are the preferred methods for cooking tender meats.

In cooking any meat our aim is to keep in the flavor and juices. To realize it the meat should be seared, regardless of the manner in which it is to be cooked. Searing means placing the meat in a very hot frying pan in which there is a small amount of fat, and turning it several times until the surface is browned and hardened so the juices cannot escape.

**Steaks.** Steak that is to be broiled should be cut at least 1½ inches thick and cooked over live coals, or in a frying pan. In pan broiling, which is a method used quite frequently, heat the frying pan very hot and sear the steak on both sides, then lower the temperature so the meat may cook entirely through. Turn frequently, using a spatula or cake turner instead of a fork; if a fork is used, some of the juices of the meat will be lost through the holes made by it. After it has been seared, and turned 3 or 4 times, a pan-broiled steak may be placed on the back of the stove or in the oven to finish cooking. Broiled steaks should be served at once. Place pepper, salt and butter in a hot platter, then remove the steak from the pan to the platter. Add the same seasonings on the top of steak, and garnish.

The best steaks are (1) porterhouse steaks; (2) sirloin steaks cut lower on the loin; and (3) round steaks, which are good if the animal is very fat and if the inside or top round is used. The outside or bottom round is less desirable. Many women ruin choice, tender steaks by dredging them in flour and frying them in lard.

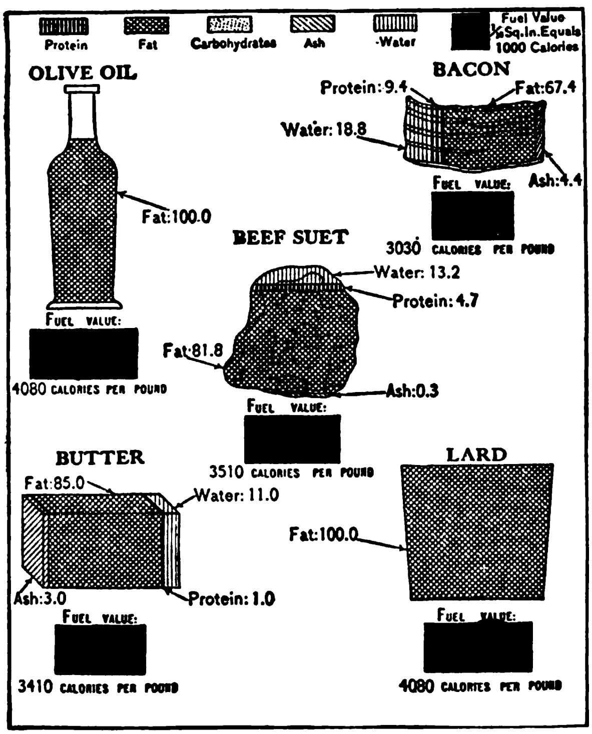


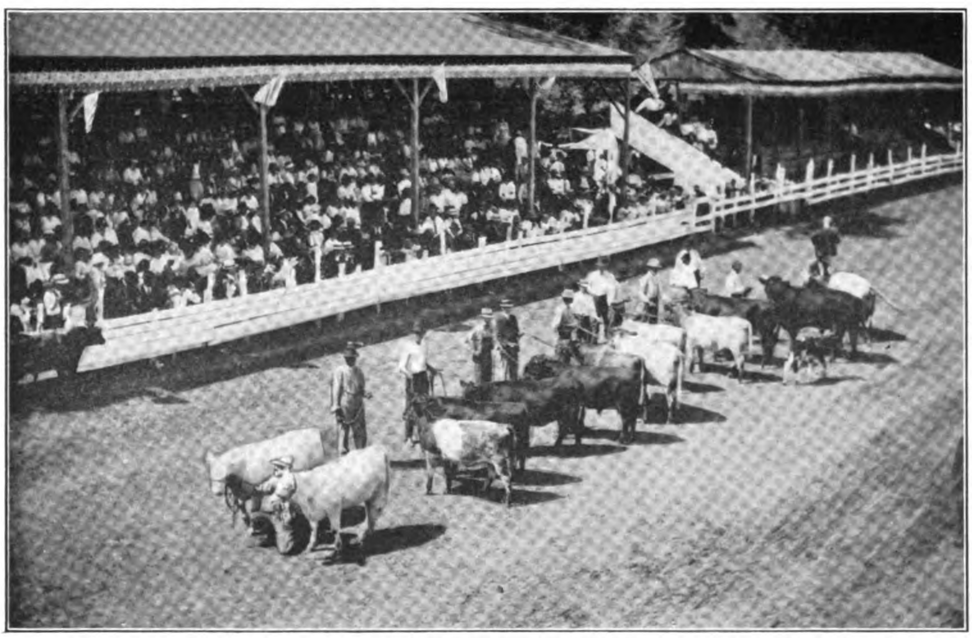

FIG. 149. Composition and fuel value of some common fat foods.

**Roasts.** Roasting and broiling involve the same principles. The meat is seared in a roaster on a rack which holds the roast above the fat which cooks out. The fat side of the meat should be on top. If there is not much fat, skewer on an extra piece, or place strips of bacon on top. When this is done the meat bastes itself as the fat cooks out and runs down the sides.

The oven should be hot at first, then the temperature should be lowered. This hardens the outside, yet allows the meat to cook through without burning. Where water is added to a tender roast and the top of the roaster used the flavor and appearance of the roast is not as good. Every time a roast is basted with a mixture of fat and water, the crust formed by searing is dissolved, allowing juices to escape. For a tough roast, water is necessary, but the tender roast should be cooked by dry heat.

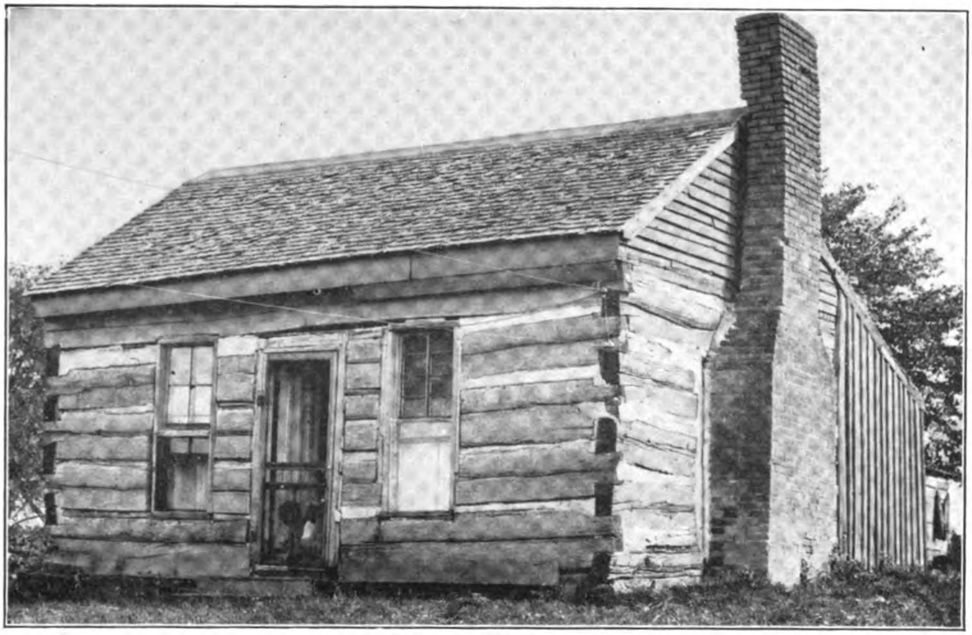
The rib roast (third and fourth ribs) is usually considered the ideal cut for roasting in an open pan with dry heat. The following table showing how the time of cooking varies with the kind and size of a roast, has been prepared

One rural community gets together for an annual fox hunt, with which is combined one of a series of farmers' institutes



Neighborhood livestock shows stimulate effort and local pride in the contestants and bring increased reputation and business to the community

ANY ACTIVITY THAT BRINGS THE MEMBERS OF A COMMUNITY TOGETHER WHETHER IN FUN, OR IN EARNEST, OR BOTH, IS A SIGN OF PROGRESS



This type of farm home, now to be found only in few localities, was a common sight when pioneer farmers were laying the foundations of the nation

Every farm home is also a place of business—but too many are only that and nothing more. Their profits should be measurable in terms of comfort as well as cash

BETTER FARMING MEANS NOT ONLY LARGER AND BETTER CROPS, BUT ALSO BETTER, HAPPIER HOMES

by Louise Stanley of the University of Missouri:

| KIND OF ROAST | WEIGHT IN LBS. | TIME OF COOKING | TIME PER LB. |
|---|---|---|---|
| Rib (2 ribs) | 8 | 2 hrs. 11 min. | 16 min. |
| Rib (2 ribs) | 9½ | 2 hrs. 45 min. | 17 min. |
| Loin | 12 | 2 hrs. 43 min. | 13½ min. |
| Round (very thin) | 3¾ | 39 min. | 10½ min. |
| Round | 6 | 1 hr. 9 min. | 11½ min. |

The tough, and therefore cheaper, cuts are found in that part of the body which does the most work; but often the flavor of tough meat is better than that of tender meat. The following methods of cooking tough meat are suggested:

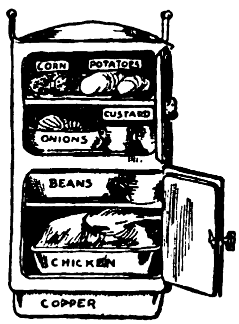



FIG. 150. A steam cooker in which an entire meal can be prepared at one time.

Swiss steak. This method may be used for chuck and round steaks. Beat flour into both sides; this helps to break apart the fibers. Sear in a hot pan and cover with boiling water. Place cover on pan. Let simmer 35 to 45 minutes if a small steak, or 1 to 1½ hours if a large one. The pan may be placed in the oven and tomato juice may be added instead of water; onions also may be added. When ready to serve, the liquid should be of the same consistency as gravy. Add seasonings 15 or 20 minutes before removing from stove.

Hungarian goulash. Cut the meat (neck is often used) into small pieces. Dredge with flour and sear in a hot pan to which a small amount of beef fat has been added. Add enough hot water to cover, and place in the fireless cooker for 3 to 4 hours or cook in a slow oven for 3 hours. Vegetables and seasonings may be added about 45 minutes before removing from stove. If the gravy is too thin pour off and thicken.

Meat croquettes. Grind a tough cut of meat, season with salt, pepper, and onion juice, shape, roll in crumbs, dip in egg, and fry in deep fat.

Roast. A tough roast may be cooked in the oven at a low temperature, but the ideal way is to use the fireless cooker. Sear the roast, add boiling water, place top on roaster and cook several hours at a low temperature or place in the fireless cooker. Add seasoning about 15 minutes before it is done. Tough meats may also be served, after being cooked, in meat pies, scalloped, or hashed.

Points to remember. Remove meat from the wrapping paper as soon as it comes from the market, since the paper absorbs some of the juices. Wipe with a damp cloth; do not wash or let stand in a pan of cold water, as some of the juices will be dissolved. Keep in a cool place. Good beef is firm, with a fine-grained texture, bright red in color, with fat well distributed. Meat should have the seasonings added *after* it has been cooked, as salt tends to toughen it and to draw out the juices.

## Soups

Soup making is an art and one which every housewife should find time to cultivate. Delicious flavors may be obtained by adding leftovers of all kinds. A great variety of soups is possible if time and thought are given to this subject.

There are two general classes of soups: (a) those having meat stock as a basis, and (b) those having milk or cream as a basis.

Meat soups. In making soup, if we are seeking the best flavor, we will look for a strongly flavored piece of meat. For instance, there is more than twice the flavor in a pound of round than there is in a pound of rib; there is 25 per cent more flavor in a pound of round than there is in a pound of sirloin; a hen makes more highly-flavored soup than a frying chicken would; veal soup has less flavor than beef soup, etc. Select, then, meat from an older animal. Include a bone, because there is much good flavor and fat in the marrow which we would get in no other way. The bone should be chopped so that the flavor can get out. The meat for the same reason should be cut into small pieces and enough meat and bone should be used to give the soup a really good flavor.

If we cut up a piece of meat and put it into cold water and let it soak, we get out considerable flavor and meat juice. However, as soon as this juice is heated, curds form in it; these rise to the top and we remove them in what we call a scum. Here is the main food value in the juice, but since it looks ugly and dirty we remove it. We can cook the meat tender and get the flavor out of it more quickly if we never allow it to boil. Added advantages of letting the meat simmer are (1) that what meat was in the soup does not get stringy and dry, and (2) that more of the flavor that was in the meat stays in the soup in place of floating off with the steam to all parts of the house. If the beef is real meat it can be used in some way where flavor is not important. Some people brown part of the meat to bring out the pleasant flavor. In this case put it into cold water for half an hour, then heat slowly and allow to simmer in a *covered* vessel for from 3 to 6 hours. Strain

if desired and allow the stock to become cold. A layer of fat will form on top. In a clear soup we want the fat removed, so we take off this layer of cold fat. To remove the small bits of protein which remain even after straining, we need to put in something that will gather them up so that we can strain them out. An egg, if used correctly, does this. If we heat the soup stock and then pour in the egg it will cook in chunks and will do no good. If we beat the egg a little and add it to the cold soup stock it mixes all through the liquid. As we gradually heat the stock the egg gradually begins to cook, and as it curdles it gathers up the fine protein particles. Then when the soup is strained, all the solid substance is strained off with the egg.

What have we left in the stock? We had flavor, fat and protein to begin with; we skimmed off the fat, we strained out most of the protein. We have left chiefly water and meat flavor or extractive. Most people have the idea that this meat flavor is very strong in food value, but actually it only tastes like meat; because it gives one a well-fed, satisfied feeling, most people think that it must be real food.

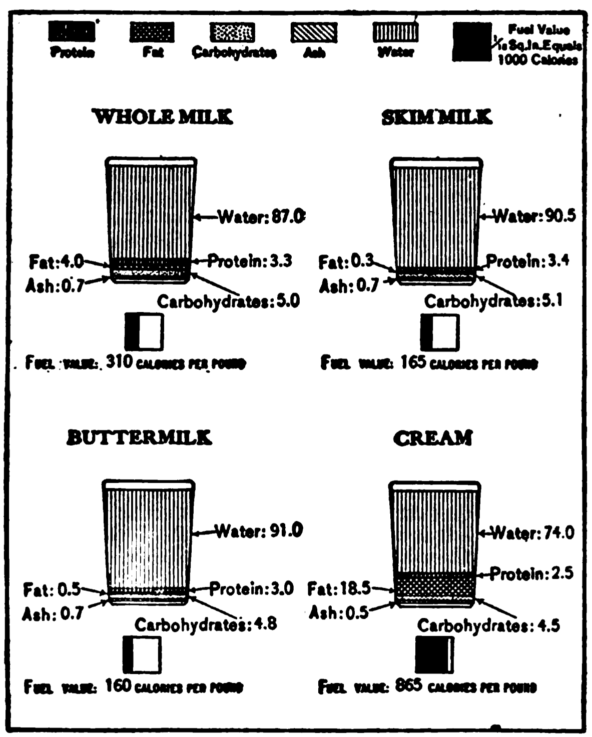



FIG. 151. Composition and fuel value of milk products. Compare Fig. 149

Why then do we use soup stock or beef tea or bouillon at all? They are expensive substances if we must buy 2 pounds of beef to make a quart of soup, which when done has no food value in it, and which wastes one or more eggs to clear it. The reason is that soups do stimulate the appetite. A clear soup served at the first of a meal smells good and tastes good, and "makes our mouths water," that is, makes the digestive juices flow more freely. That alone is a great value to us *if we follow up the soup with real food.*

Of the meat stock soups, *bouillon* is made from lean meats and vegetables delicately seasoned and cleared; *consommé* usually is made from two or three kinds of meat, highly seasoned and cleared. *Beef juice* from raw beef contains the liquid from the meat fibers. This is rich in flavor and food value, but if it is heated and strained the food value is strained off.

**Milk or cream soups.** These are made from vegetables or meat thickened until they are about as thick as ordinary cream. The amount of thickening will depend upon the starch contained in the vegetable. If it is a vegetable containing no starch, use 1 tablespoon flour to 1 cup soup. For potatoes use 1 teaspoon flour per cup of soup.

Potato soup. If we want 1 quart of soup or 4 cups, we will need 1 cup of diced potatoes. Cook these in 1 pint of water until they are tender enough to mash to a pulp. (Potatoes alone will not make a smooth cream of potato soup because the potato starch will settle and leave the soup thin at the top, so by the addition of just a little flour we hold the potato starch up so the soup will smooth.) Make a white sauce with 4 tablespoons butter or meat fat. Melt the butter, rub in the flour, let it brown a little to develop flavor, add the milk and potato water and mashed potatoes, also any other seasonings desired. This makes a smooth soup, which is nourishing because of the potato, milk and fat present. In making pea soup cook the peas in water, press through strainer, add milk; melt butter, add flour and combine with peas and milk. Cook together until thick.

Tomato soup. The twofold problem in making tomato soup is a little different. What causes tomato soup to curdle? How can this be prevented? It curdles because the acid of the tomato in the presence of heat acts on the milk, separating out its casein, or solid portion. Most housewives avoid the effects of the acid by adding soda to neutralize it, but this is

objectionable because it partially destroys the tomato flavor and it is hard to estimate the proper amount since some tomatoes are much more acid than others.

The curdling may be prevented by making a thin white sauce, using 1 tablespoon butter, 1 tablespoon flour and 1 cup of milk. Cook until it thickens and when cooled slightly add the tomatoes slowly, two thirds of a cup being a good proportion for this amount of white sauce.

Both milk and tomato juice should be at serving temperature when mixed. Pour the tomatoes into the milk, as a small amount of acid at a time in the milk will be less apt to form a curdle than a small amount of milk in a large amount of acid. Keep separate until ready to serve. If mixed and heated together, danger of curdling is increased.

Other soups. Some other non-starchy vegetables used for soups are celery, cabbage, onions, carrots, and turnips. The main points to mention in the use of these vegetables is the care to be taken in securing good flavor. Celery, tomatoes, and turnips are very delicate in flavor so that too long cooking in an open vessel makes them flat and tasteless. Cook mild-flavored vegetables in a covered vessel until just tender. The use of cabbage and onions is generally misunderstood. We are told that cabbage "liquor" is strong and not good, and that stewed onions are not desirable unless we pour off all the water in which they were cooked. If these vegetables are cooked rapidly in an open kettle and not cooked longer than is necessary to make them tender, water from them does not have a strong flavor but is quite delicate and appetizing.

The value of vegetable soups is mainly in the water from the vegetables. We have heard a lot of talk about the need of fresh vegetables and fruits to balance the diet. One reason for this is that vegetables and fruits furnish the mineral matter that "tones up" the blood, and balances that found in bread and meats. Much of this mineral matter cooks out into the vegetable water and we get it in the soup if we do not throw the water away and thus lose most of the good of our vegetables. Vegetable soups furnish a way of using vegetable water and scraps of vegetables which might otherwise be lost. Celery tops are good for making celery soup. Soups are economical means of using up liquid from vegetables and meats which would otherwise be lost.

Clear soups are valuable in the diet as appetizers, but have only a small per cent of food value. The food value ranges from almost nothing in the clear meat soups to considerable in the purees and bisques. From 15 per cent to 50 per cent of the mineral matter from vegetables comes out into the liquid in which they were cooked. Since this is the most valuable food substance in vegetables

USEFUL SOUP FORMULAS

| FOOD | THICKENING | LIQUID |
|---|---|---|
| ½ lb. soup meat | none | 1 cup water |
| Tomatoes | 1 tablespoon | ½ cup tomato juice<br>½ cup milk |
| ¼ to ½ cup potatoes | 1 teaspoon | ½ cup potato water<br>½ cup milk |
| ¼ cup corn | 2 teaspoons | ½ cup water<br>½ cup milk |
| 1 cup peas | 2 teaspoons | 1 cup broth |
| ½ cup salmon | 2 teaspoons | 1 cup water |

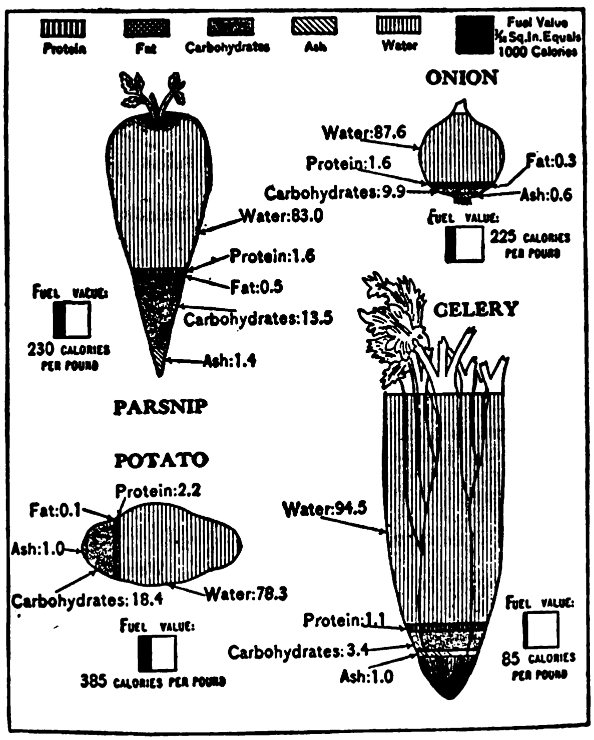



FIG. 152. Composition and fuel value of some vegetables. Most of these are valued chiefly for their mineral content

such as cabbage, onions, spinach, celery, etc., we are guilty of waste when we throw away the liquid. Flavor is destroyed or made less delicate by long cooking, so vegetables should be cooked until just tender; and soups should always be served hot.

## Vegetable Cookery

Vegetables are cooked to make them more digestible and more palatable. They may conveniently be classified as follows: (1) *Roots, tubers, or bulbs;* examples—sweet potatoes, beets, carrots, parsnips, radishes. (2) *Underground stems;* example—potato. (3) *Stems;* example—asparagus. (4) *Leaves;* examples—cabbage, lettuce. (5) *Flowers;* example—cauliflower. (6) *Fruit;* examples—tomato, cucumber, squash, peppers. (7) *Seed;* examples—all legumes, grains.

The principal method of cooking vegetables is by boiling. Other methods are: baking, cooking in casserole, frying, sauteing and escalloping. Do not throw the water away in which vegetables are cooked except in the few cases in which the flavor is undesirable. Much of the valuable mineral matter is lost if this practice is followed.

The use of a greater variety of properly cooked vegetables in the diet is highly desirable. They contribute minerals which are necessary for the proper development of the body. There is no better way to get the various members of the family to eat more vegetables than by preparing them well.

**Vegetable time-table.** (For stewing and boiling unless stated otherwise.)

15 minutes: Tender cabbage and sweet corn. These are usually cooked too long.

30 minutes: Asparagus; peas; potatoes of medium size; summer squash; tomatoes.

45 minutes: Young beets and carrots; onions; young parsnips; medium-sized potatoes, baked; sweet potatoes boiled.

1 hour: String and shelled beans; cauliflower; oyster plant; winter squash, steamed or baked; young turnips.

2 hours: Old carrots, beets, and turnips.

6 to 8 hours (or more). Dried beans, lentils, and peas, baked in the oven, with water added.

## Salads and Salad Dressing

Only recently has the housewife realized the importance of the salad as part of her daily menu. Now we find the dessert course omitted rather than the salad course. A good salad adds to the attractiveness of any table.

**Salad dressings.** There are 3 types of salad dressings—French, mayonnaise, and cooked dressing.

*French dressing* is made by mixing 2 to 3 parts of oil with 1 part of acid, the proportions differing according to taste. The acid may be vinegar or lemon juice, which makes a more delicate dressing. Instead of olive oil, any of the commercial salad oils may be used. These are less expensive and have practically the same food value. The seasonings are paprika and salt, although some add others such as pepper, mustard, etc. The following proportions are very good: 2 tablespoons of vinegar, or lemon juice, 4 tablespoons of olive oil; ½ teaspoon of salt, and ¼ teaspoon of paprika. Add the salt and paprika to the oil, then pour into the acid, beating all the time. French dressing may also be mixed by shaking the ingredients in a bottle. If allowed to stand, it separates and therefore should be well mixed just before serving.

*Mayonnaise dressing.* Egg is used in mayonnaise dressing and is the only difference in the ingredients used in mayonnaise and French dressings. It is difficult to give the proper proportions because individual tastes

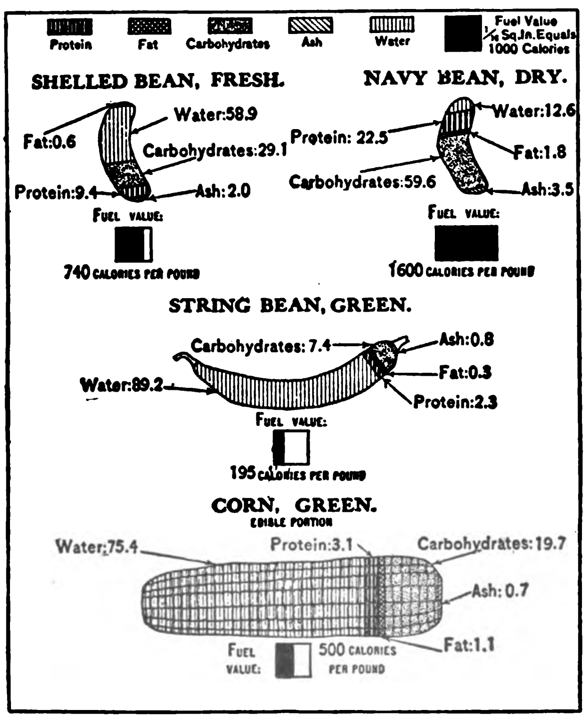



FIG. 153. Vegetables contain so much water that their food value is apparently low, but they should be eaten freely

differ greatly. One-fourth to 1 cup of olive oil may be used to 1 egg yolk, but the average amount is ½ cup of oil. Beat the egg yolk, add seasonings, then the acid and mix thoroughly. Into this mixture drop the oil slowly at first, beating constantly. When it begins to thicken, the oil may be added more rapidly. If too thick, thin with acid. While French dressing separates in a short time, mayonnaise will stand for a month if kept covered and in a cool place; if left uncovered it dries out. An average recipe is 1 egg yolk; ½ cup olive oil; 1 tablespoon of lemon juice (more if needed); 1 teaspoon of salt; ½ teaspoon of paprika.

*Cooked dressings.* There are 2 kinds of cooked dressing—one made from a custard foundation, the other from a cream sauce foundation.

*Custard dressing:* 4 whole eggs or 8 yolks; 1 cup of vinegar; 2 tablespoons of sugar; ½ teaspoon salt; whipped cream.

Heat the vinegar in the top part of a double boiler and pour slowly into the beaten eggs. Add the seasoning and cook the mixture over water till thick. When cool, thin with cream, either plain or whipped. This dressing is especially good for fruit salads, so no mustard or pepper is added. If fruit juices (lemon alone, or lemon and orange, or lemon and pineapple) are available, they may be substituted for the amount of vinegar given above.

*White sauce dressing.* This dressing is cooked directly over the fire, since the egg is not added till done. Melt 2 tablespoons of butter and stir into it 2 tablespoons of flour. Add ½ cup of water slowly, stirring all the time. Cook until thick, then add ½ cup of hot vinegar and cook quickly until very thick. Remove from the fire and add 1 or 2 whole eggs or 2 to 4 yolks. Season with salt, sugar, mustard and paprika as desired. This dressing is thinned as needed with cream or beaten egg white. It will keep indefinitely and is an excellent cooked dressing for meat and vegetable salads. It is more economical than the custard dressing and can be made even when eggs are expensive.

*Salads.* Salads may be divided into 2 classes—light and heavy. Typical examples of light salads are: Cucumber and tomato, asparagus and pimento, grapefruit and lettuce, cabbage and green peppers. Heavy salads have a foundation of meat, eggs, cheese, fish, potatoes, or peas.

The kind of salad served depends upon the remainder of the meal. If the meat and vegetable course is heavy, the salad should be light. On the other hand, a heavy salad may be used as the main part of the meal. No salad is complete without some salad plant, such as lettuce, water cress, celery tops, cucumbers, cabbage, or endive.

Salad points. (1) Salads should be cold and crisp. (2) Salads should be attractive; use colors which harmonize and flavors which blend. (3) Salad dressings, with the exception of French dressing, should be thick; always combine with the salad just before serving. (4) Materials for salads should be cut into pieces of uniform size but not too fine. (5) Bananas, apples, and pears may be kept from discoloring by dipping in lemon juice. (6) Garnishings should be dry, since water thins the salad dressing. (7) Salad plants will retain their freshness if wrapped in a moist cloth and kept in a cool place. (8) Egg yolk set aside for salad dressings will keep without hardening if covered with melted butter or water.

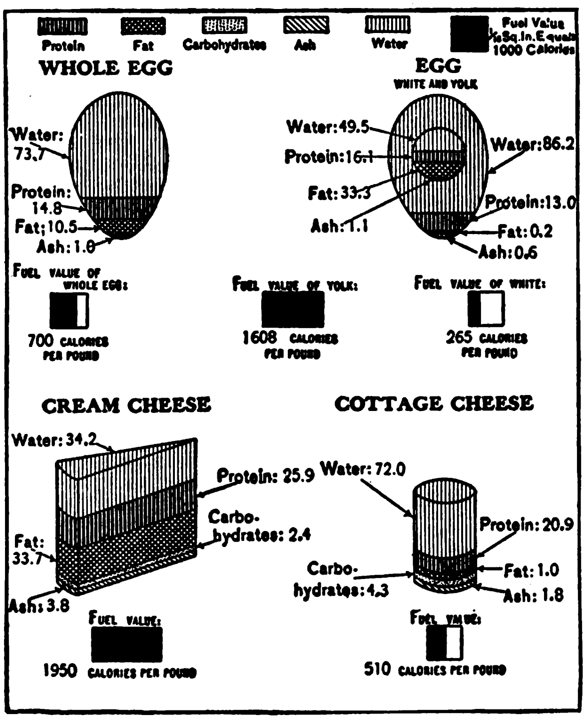



FIG. 154. Eggs (especially their yolks) and cheese are highly valuable, digestible and palatable foods

## Egg Cookery

Eggs are rich in all those elements which enter largely into the construction of muscle, bone, and blood. In addition to their well-known high nutritive value they are very popular, since they are easily cooked in a variety of ways. Then, too, by mixing them with other foods, it becomes possible to make many modifications in texture, flavor and appearance of the other food materials. It seems strange that, since it requires only a little care, forethought and knowledge of the details to cook an egg correctly, we should find them cooked incorrectly in so many homes.

**Soft-cooked and hard-cooked eggs.** The fact that most people say "soft-boiled" and "hard-boiled" eggs, suggests that the right method is not used. We do not want to put eggs in boiling water and let them boil for so many minutes, for if we do, they will become hard, tough and leathery and as a result, difficult to digest. To soft cook an egg have the water just at the boiling point, drop in the egg and place on the back part of the stove, leaving for 4 or 5 minutes, the length of time depending somewhat upon the size of the egg and whether it was just taken from the ice-box. When the egg is dropped in the boiling water, the temperature is lowered almost immediately to 185 degrees Fahrenheit and then slowly to 170 or 171 degrees.

For hard-cooked eggs the same method is employed except that they should be cooked for 45 to 60 minutes at 180 to 190 degrees, in order that they may be mealy and not tough. Eggs put into hot water do not stick to the shell, and also cook more evenly than when put into cold water.

**Poached eggs.** To poach an egg is no easy matter, but a little care will bring good results. Some people poach their eggs by boiling them in a pan of water, having the water boiling when they are dropped in; other people drop the eggs in cold water and bring them to the boiling point. It has been found that the best method is to have the water a little below boiling. Pour boiling water into a shallow pan which has been brushed over with oil or butter. Break the egg carefully into a cup and slip gently into the water. The egg quickly reduces the temperature to about 185 degrees, which is correct for poaching. Let the egg cook gently and when a film has formed over the yolk and the white is firm, lift out with a ladle, drain, and place on a piece of hot toast. Put on a little piece of butter and sprinkle with pepper and salt and serve at once on a hot plate. When properly poached the egg is jelly-like throughout and the yolk is covered with a white film.

**Fried eggs.** Fried eggs, especially as prepared in many homes, are more difficult to digest than eggs cooked in any other way. A great deal of grease is put into the skillet and when it becomes smoking hot, the egg is dropped in and cooked at very high temperature. As a result it is very hard, tough and leathery and surrounded with a coat of fat. Instead, we should fry eggs as follows: Place a medium amount of fat in the pan, having it only slightly hot; then add the eggs and one teaspoon of water for each egg. Place a top over the pan to keep in the steam and cook at a very low temperature. When the eggs are done a film will cover the top as in the well-poached eggs (that is when we use the top on our pan).

**Omelets.** An omelet is an egg beaten very light, with a small amount of milk or cream sauce added. The best method is to beat the whites to a stiff froth, then beat the yolks; add pepper and salt, and milk or cream sauce. Vegetables, such as peas, peppers, asparagus, and onions, may be added after being thoroughly mixed with the yolks. Fold in the whites very gently so as not to break the air cells. To 1 egg, 1 tablespoon of milk may be added, but more makes it too thin, unless in the form of a cream sauce, of which from one fourth to one third cup may be used. After the whites and yolks are blended, place in skillet slightly greased and cook at very low temperature; be careful not to let it get too hot on the bottom. When it becomes firm place on a plate and fold one-half over. A fallen, soggy omelet usually results when it is not cooked slowly enough and when not cooked throughout.

Sponge cake and angel food cake may be considered as variations of an omelet. In these we should be very careful in mixing in the beaten

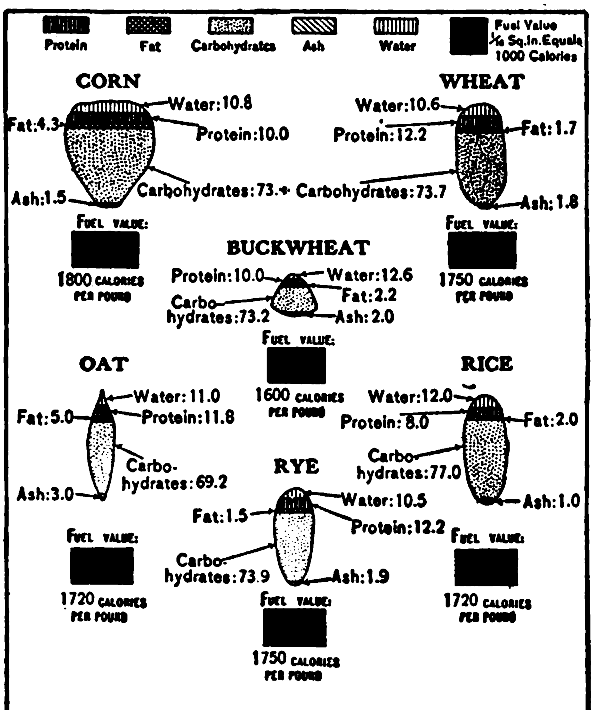



FIG. 155. Grains are robbed of much of their most valuable food materials by too great refining in the milling

egg whites, not to break the air cells, and we should watch our oven that we do not have it at too high temperature. For a large loaf the oven should be about 150 degrees and at the end should be brought up to 180 degrees.

**Custards.** Eggs play an important part in custards. Here also the egg should be cooked below boiling. Where cornstarch is substituted for part of the egg, the starch (which should be boiled) should be cooked in the milk before the egg is added. A very good way to keep a baked custard from cooking at too high temperature is to place the baking dish in a pan of water.

## Beverages

**Coffee.** To make good coffee it is necessary to extract the flavoring elements and avoid the extraction of the element called caffein, either by long boiling, or by allowing the liquid coffee to stand on the grounds after it has been boiled. The flavor also is lost by long standing.

There are four general methods of making good coffee: (1) The cold-water method, (2) dripping, (3) boiling, and (4) percolating.

*Cold-water method.* Probably the best way to make coffee is by the cold-water method. Place the coffee in the desired amount of cold water and let stand over night. In the morning bring to a boil and serve at once. Usually 1 to 1½ tablespoons of coffee are used per cup.

*Drip coffee.* Various coffee pots are sold for making drip or filtered coffee, but the principle is the same in all. The coffee is put into a strainer, the boiling water is poured through it and allowed to collect at the bottom of the pot. If the liquid is not strong enough it may be poured through the grounds a second time, the pot being kept in a warm place. Coffee must be ground fine for drip coffee.

*Boiled coffee.* Use 1 cup of ground coffee, 1 cup of cold water, 6 cups of boiling water, and 1 egg white. Beat the egg, add ½ cup cold water, and mix with coffee. Put this in the coffee pot, pour on the boiling water and stir thoroughly. Boil 3 minutes, then add the remaining ½ cup of cold water. Cold water is heavier than hot water, and sinks carrying the grounds. This as well as the egg helps to clear the coffee. Set in a warm place 5 or 10 minutes, and serve.

*Percolator coffee.* There are several kinds of percolators on the market, but in all of them the water boils in the pot and passes through the coffee at boiling temperature. At no time in the process does the coffee stand on the grounds.

Ground coffee is often adulterated with chicory root which has been washed, sliced, dried and roasted. A small amount of chicory added to coffee makes the infusion appear a dark brown. The addition of chicory is a fraud on the consumer, and it may also prove injurious. If ground coffee is dropped into a glass of cold water the genuine coffee will float and will not discolor the water for several minutes. Most adulterants sink to the bottom, leaving a brown trail in the water. The careful housewife always grinds her coffee at home or watches her grocer while he grinds it. Coffee should be bought in small quantities and kept in airtight receptacles so the flavor will not be lost.

**Tea.** The careful making of tea is as important as that of coffee. The tea leaves should be allowed to come in contact with hot water only long enough to extract the volatile oil and some of the tannin. Tea never should be boiled. Many women boil tea 10 to 15 minutes, and then allow the portion not used to stand until the next meal. The bitter taste of iced tea in many hotels and restaurants is often due to the fact that

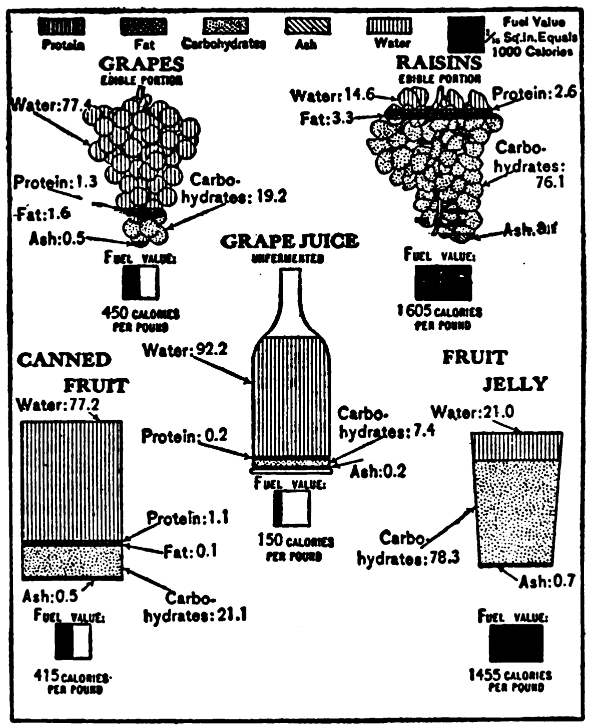



Fig. 156. Fresh fruits and their juices are refreshing rather than sustaining. Raisins are rich in iron and other minerals

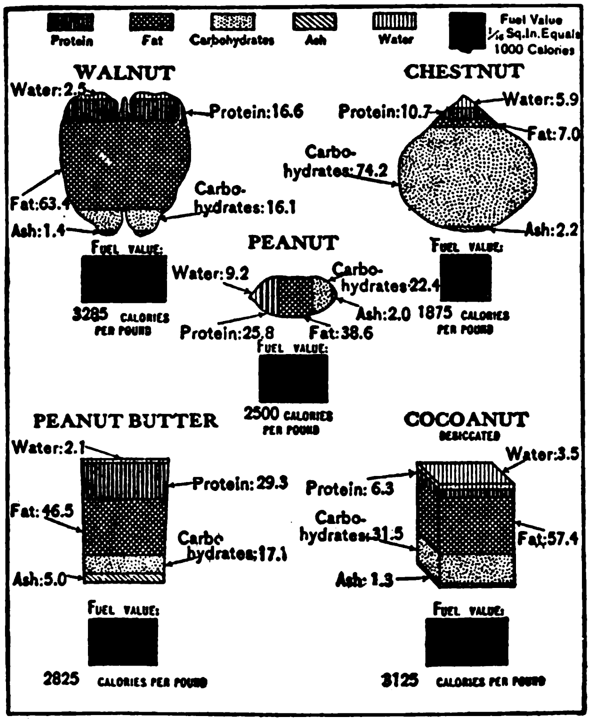



FIG. 157. Nuts require thorough grinding or chewing if their full value is to be obtained

the tea leaves were boiled, allowed to stand in water from one meal to another, and then boiled a second time before serving.

In the preparation of tea, hard water should be used. Soft water extracts a bitter principle from the leaf. Water boiled a long time becomes "flat"; so the water used for tea should be freshly boiled. To make the tea, scald an earthenware or china tea pot; put in the tea leaves (3 teaspoons to 2 cups of water is a good proportion) and pour on the boiling water; set in a warm place 5 minutes; strain and serve immediately. Sugar, cream or lemon may be added. Never add fresh leaves and steep a second time. Too much tannin will be dissolved.

The "tea ball" is now being used extensively. Usually about 1 teaspoon of tea is placed in it and held in the cup of hot water until the infusion is of the desired strength.

For iced tea use 4 teaspoons of tea and 2 cups of boiling water and make in the usual way. Strain into glasses one-third full of cracked ice. The flavor is improved by chilling the tea quickly. Sugar and lemon are usually served with iced tea.

Cocoa and chocolate. These are both prepared from seeds of the cocoa bean. Cocoa consists of chocolate from which the fat has been removed, and which has been mixed with sugar, starch, and flavorings. Many persons drink cocoa because it is not as rich as chocolate. The action of cocoa and chocolate on the nervous system is much less than that of tea and coffee, and they may be regarded as foods as well as stimulants.

*Cocoa.* Use ¼ cup cocoa; 1 cup water; 3 cups milk; ¼ cup sugar. Mix cocoa, sugar and water together and boil for 10 minutes. Add milk, heat to boiling point and remove from heat. Beat with an egg beater.

*Chocolate.* Use 2 squares chocolate; 1 cup boiling water; ⅙ cup sugar; 3 cups milk; flavoring. Melt the chocolate, add the sugar and then add the water. Boil for 10 minutes, add milk which has been heated in double boiler, and remove from heat. Beat with egg beater.

The influence of all these beverages may be considered, on the whole, as unfavorable. Coffee and tea cannot be considered as foods, but as stimulants. Children never should be allowed to drink coffee; but cocoa and chocolate, when served in small portions with large amounts of milk, may be given to them. They are much used by invalids. Coffee removes the sensation of fatigue, allays hunger and stimulates the heart action. The coffee habit often is developed by using the beverage to aid one in keeping awake or in doing extra amounts of work. Insomnia and dyspepsia may result. Tea is also a stimulant, and often relieves fatigue. It should be avoided by any one suffering from dyspepsia or constipation.

## Cake Making

Every cake may come up to the standard if the housewife understands and puts into practice the principles of cake making. If she knows these principles she will get good results from any reliable recipe, and she will also be able to tell at a glance when a recipe is incorrectly proportioned.

Used in a broad sense, the word cake includes those loaves made with yeast and allowed to rise before baking. In its more restricted meaning, it comprises loaf and layer cakes made by some other method. From the standpoint of composition, sponge cake really groups itself with omelets (p. 196), so will not be discussed here. Only cakes made with fat will be considered.

The ingredients essential for cake are flour, liquid, sugar, egg, fat, and baking powder.

Other ingredients such as nuts, spices and flavorings are added for the sake of variety.

There are 2 kinds of flour: *bread flour* or hard-wheat flour made from wheat sown in the spring, and *pastry flour* or soft-wheat flour made from wheat sown in the fall. Pastry flour differs from bread flour in that it contains less gluten and more starch; it is smooth to the touch, packs easily, and retains the impression of the fingers when pressed in the hand. Bread flour, on the contrary, does not pack and is granular to the touch. Pastry flour makes a lighter and more tender cake and is preferable for cake making. If only bread flour is to be had, it is well to substitute 2 tablespoons of cornstarch per cup of flour in place of the same amount of bread flour. Always sift flour twice before measuring; fill the cup by lifting the flour lightly into it, rather than by dipping the cup down into the flour.

*Fat* is used to make the cake more tender, by keeping the particles separate. While butter gives the most desirable flavor, other fats may be used in cake making, especially in dark cakes; but since butter is only 85 per cent pure fat the substitutes cannot be used in equal proportions. The equivalents of two thirds of a cup of butter are approximately: Lard, half a cup plus 1 tablespoon; Crisco, half a cup plus 1 tablespoon; chicken fat, two thirds of a cup. (Half a teaspoon of salt should be added to these fats.)

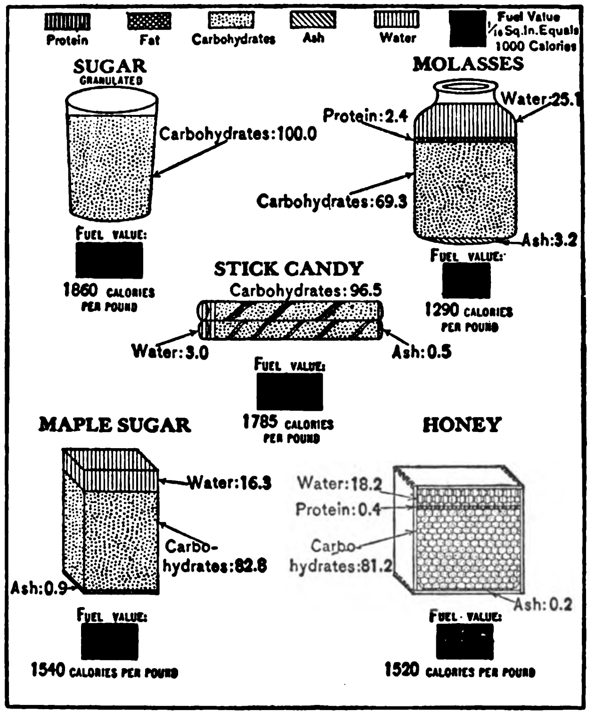



FIG. 158. Candy and other sweets should be eaten as part of the daily ration, not in addition to it

Fine granulated *sugar* should be used, as coarse sugar gives a coarse texture.

The *liquid* generally used is milk, but when necessary, water may be substituted. Since the composition of milk is about one eighth solid material, seven eighths of a cup of water equals one cup of milk. The amount of liquid required will vary since different grades of flour absorb different amounts of liquid, while the same grade will often absorb more at one time than another.

*Eggs* have the effect of making the particles stick together. If the amount of egg is increased, the amount of liquid may be decreased, since egg behaves as a liquid when added to the batter. One beaten egg white is the equivalent of about half a teaspoon of baking powder. Hence, as the egg whites are decreased the baking powder must be increased.

Learn to make one cake well and vary it by changing the form and flavors. A good formula for a plain white cake is: Flour, 3 cups; baking powder, 3 teaspoons; butter ⅔ cup; sugar, 1½ to 2 cups; milk, 1 cup; whites of eggs, 4 to 6; flavoring. When we consider the long list of spices and extracts, fruits and nuts available, we see how it is possible to make many kinds of cake on one such foundation.

The following suggestions are offered by a New York (Cornell) bulletin: (1) *Chocolate* contains both starch and fat: hence, when chocolate is added to the plain foundation, less flour (1½ cups chocolate equals 2 tablespoons of flour) and less fat are required. (2) When *nuts* are added, less fat is required, since 1 cup of nuts equals 1 to 2 tablespoons of fat. (3) A *fruit cake* requires a rather stiff batter; otherwise the fruit will fall to bottom of pan; ordinarily, if the fruit is well floured, a sufficient amount will thus be added. (4) When *spice* is added, scald it to insure more thorough mixing and better flavor; a good mixture is 1 teaspoon cinnamon, ½ teaspoon cloves, 2 tablespoons hot water.

**Making cake.** Collect all utensils and ingredients before beginning to mix cake. Then measure all ingredients to be used. The cake may be mixed either the old or the new way. (a) If using the old method, cream the fat and sugar; add flour and baking powder alternately with liquid; fold in the well-beaten

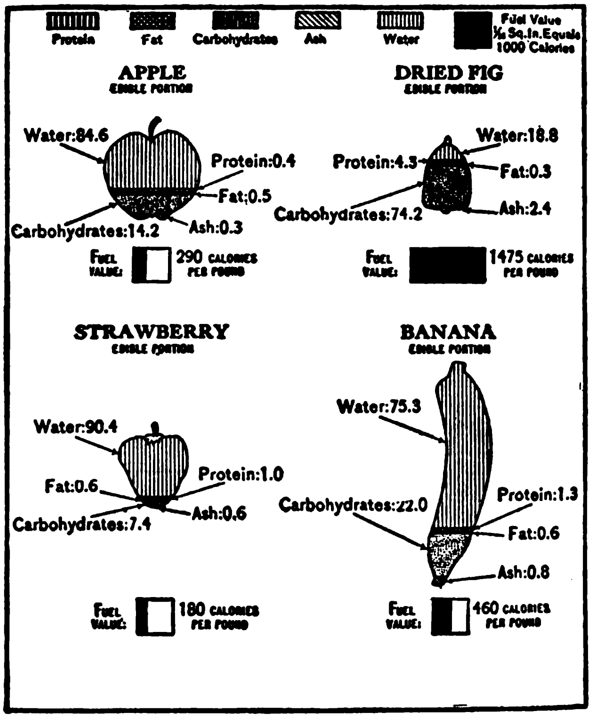



FIG. 159. Fruits have a beneficial effect on the digestive system in addition to their value as food

whites of eggs. (b) In the new method, put liquid and melted fat into mixing bowl; sift in dry ingredients—flour, sugar and baking powder—and mix thoroughly; fold in the well-beaten egg whites; oil pans and dust lightly with flour. If the pan is rough, place paper on the bottom; put batter into pans (filling two thirds full); with a spoon or spatula bring the batter toward sides of the pan, leaving center lower than at sides.

The oven is a very important factor in cake making. The insulation is the important part and the keeping of a definite temperature a given length of time depends upon its perfectness. Cakes are very often spoiled by uneven temperatures. An oven that will turn a piece of white paper golden brown in 5 minutes is a good layer cake oven. Loaf cakes require an oven of a slightly lower temperature. A cake is thoroughly cooked when it shrinks from the sides of the pan and rebounds to the touch of the finger. When cake is removed from oven, let stand a few minutes, then turn out on a wire cake cooler.

**Causes of cake failure.** (1) Too little flour makes cake fall because there is not enough gluten to stiffen it and hold it up; too much flour makes cake crack open. (2) Too little sugar makes cake bread-like; too much makes it fall and gives a moist, sticky crumb and a sugary crust. (3) Too little fat causes cake to crumble; an excess makes it heavy. (4) Too much liquid makes cake undersized and the texture porous. (5) If oven is too hot, the cake cracks; if too slow, the cake rises, but soon falls.

**Icing.** When well made this increases the palatability and attractiveness of cake. By helping to retain the moisture of the cake it also adds to its keeping quality. To make it, boil 1 cup of water and 1½ cups of sugar very slowly until the syrup threads. Do not stir while cooking. Pour slowly into the well-beaten whites of 2 eggs, beating constantly. Continue beating until the icing is cool and stiff enough to spread on the cake. This frosting is delicious with nuts and fruits added. A cup of blanched almonds, pounded to a paste, or a cup of hickory nut or pecan nut meats, chopped fine, makes an excellent nut filling. Chopped figs, raisins, and nut meats mixed together are rich and delicious with this frosting. For chocolate frosting add 2 squares (or 2 ounces) of chocolate before cooking, or melt the chocolate and add after beating.

## Frozen Desserts

With a farm supply of ice, frozen desserts are easy to make and not expensive. Furthermore, our diet will be improved when we cease to think of ices and ice creams as belonging to the occasional "company dinners," and use them more often in place of hot, rich puddings and pastry. Some people claim that ices and ice creams are unhealthful. This is probably because they are usually eaten too fast. Then, too, some people eat too much ice cream; they do not realize they are getting a real food. Again, these frozen foods are eaten at all hours and after sufficient food has already been taken. Ice cream, owing to its high food value, belongs with a light meal, while the fruit ices, which are not so rich, may be added to the heavier meal.

**Ices.** Water is the foundation of ices. A plain ice calls for water, sugar and fruit juice. Fruit pulp may be added to it. Dissolved gelatin may also be added with or without the pulp, as may also beaten egg white (when ice is partly frozen). Finally milk or cream (sweetened) may be added to give more body and richness. Lemon should form the basis of all ices. All ices should be made of a syrup of sugar and water. Boil the sugar and water

slowly for 10 minutes; remove from heat, add fruit juices or thoroughly crushed, sweetened fruits, and cool; freeze. A recipe for making raspberry ice, which may be used as a basis for all ices, is: 4 cups water, 1⅔ cups sugar, 2 cups raspberry juice, 2 tablespoons lemon juice. Make a syrup by boiling the sugar and water 10 minutes; cool and add the raspberries, which have been mashed and run through a sieve; add lemon juice and freeze. Remove, cool, and add the cream. Freeze.

Iced beverages should be given an important place in our menus during the summer months. The following recipe is useful: *Lemonade.* Make a syrup by boiling 1 cup of sugar and 2 cups of water very slowly for 10 minutes. Remove from stove, add one-third cup of lemon juice, and cool. Dilute with ice water according to individual taste. Lemon syrup may be bottled and kept indefinitely. This method is not only a great convenience but less sugar is required and a more delicious beverage results. Lemonade made of lemon juice and orange juice rather than lemon juice alone, is preferred by many.

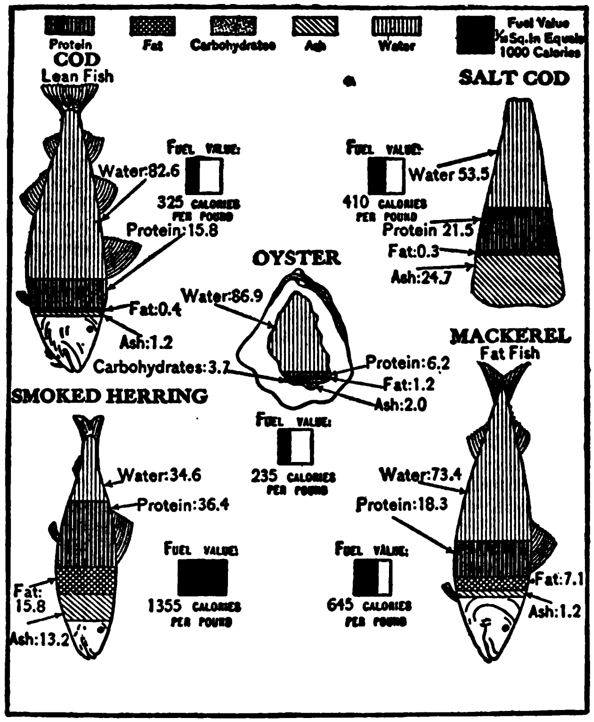



FIG. 160. Fish have less energy value than meats, but provide a very valuable variety

Ice creams. Milk or cream is the foundation of ice cream. Plain ice cream uses cream, sugar and flavoring. To vary it, add dissolved gelatin, flour or corn starch, beaten egg yolks (when partly frozen), whipped cream or beaten egg white, or soft custard. To any of these may be added any flavoring, fruit juice or juice pulp well sweetened. Fruits should be thoroughly crushed and sweetened.

*Plain ice cream.* The simplest type of ice cream is made by combining sugar, cream and flavoring. Usually 1 cup of sugar to a quart of cream is used. Dissolve the sugar by heating it in a small portion of the cream. Add the remainder of the cream to which flavoring has been added, and freeze.

*Custard ice creams.* Too often we find milk, sugar and eggs combined and frozen without first being cooked. These same ingredients, if used correctly, make delicious ice creams. Make a custard of eggs, sugar, and milk and add an equal proportion of cream, then freeze. This type of custard cream is especially desired when the housewife's supply of cream is low. One quart of milk, 4 eggs, 2 cups of sugar and 1 quart of cream are the usual proportions. Cook eggs, sugar and milk in a double boiler.

*Strawberry ice cream.* Wash and stem 1 quart of berries. Sprinkle with ½ to 1 cup of sugar, depending upon the sweetness of the berries. Let stand one hour. Mash and rub through a strainer. Make a custard of 1 pint of milk, 2 eggs and 1 cup of sugar. Cool and add 1 pint of cream. Partially freeze; add berries, and finish freezing.

*Freezing.* Use 3 parts of crushed ice and 1 part of salt. Mix the salt and ice thoroughly before adding to the freezer.

There is a hole in the wooden part of the freezer—this is to let out the salt water. Some people make the mistake of putting a hole in the freezer down toward the bottom so that the water will run off. This is a mistake for the salt water is the coldest substance around the cream. It takes the heat out of the cream much better than air spaces between the ice would. Therefore, save the ice water, just so it does not get high enough to get into the cream. If rock salt is used, it may be saved from each freezing and used again.

## The Principles of Candy Making

Candies are divided into four general classes: (1) brittle, (2) crystallized or cream, (3) non-crystallized, and (4) texture. With a few exceptions, in which confectioners' sugar

is used, cooking is a part of the process of candy making. When no liquid is added in heating sugar, we have *brittle candy*. The sugar is melted over the fire in a pan, being stirred constantly to prevent burning. It may be poured over peanuts, cocoanut, or other nuts, in a buttered pan or platter.

*Crystallized or cream candies* which make up by far the larger group, comprise those made by heating water and sugar. Fudge and fondant are examples of this class.

*Non-crystallized candies* include butterscotch, caramel and taffy.

Cream candy added to egg-white, gelatin or gum arabic, is classified as *texture candy;* divinity and marshmallow are examples of this kind.

**Fondant.** If one understands the principles of making fondant, other candies are more easily made. Fondant is the cheapest of all homemade candies and the foundation of many kinds; also it is easily made. To make fondant, add 1½ cups of water and ¼ teaspoon of cream of tartar to 5 cups of sugar. Stir until the sugar is dissolved but no longer. Cook slowly to the soft-ball stage (238 degrees F., or 113 degrees C. See accompanying table) continually wiping down the crystals from the sides of the vessel with a damp cloth wrapped around a fork. When done, pour the sirup on a platter. When cool enough to allow the finger to be held in it, stir with a wooden spoon until it creams. Then knead till smooth. Wet and wring a small towel, place it over the fondant, and allow it to remain there for an hour; this is called the curing process. One of the good points of fondant is that it does not become stale; in fact, it improves when kept for some time.

For cinnamon balls, shape the fondant and roll in powdered cinnamon. For caramel creams, flavor with caramel. This flavoring can be made by melting sugar, then adding water, and cooking until it becomes a thick sirup. For chocolate creams, melt chocolate and dip in the cold fondant which has been shaped.

Fruits and nuts are especially good when dipped into melted fondant. White grapes treated in this way give a dainty touch to a box of candy.

**Fudge** may be made as fondant. When the sirup is placed in a platter to cool, cut the chocolate in small pieces, and add to the sirup. It will melt, and when beaten produces a delicious fudge.

**Texture candy.** To make divinity candy, use 3 cups of sugar, 1 cup of water, and ¾ cup of sirup. Cook until it forms a hard ball (248 degrees F., or 120 degrees C.). Pour it into the well-beaten whites of 3 eggs. Add 1 cup of nuts and beat until creamy. Shape into long loaves and place on a plate over which cold water has been poured, leaving the plate wet. Do not use butter, as its flavor is not desirable in this kind of candy.

**Non-crystallized candies.** These may be divided into 2 groups: those which are to be pulled and those which are not. Butter scotch and caramel, which require no pulling, and taffy, which is pulled, are representative of this class. To make butter scotch, use 1 cup of sugar, ¼ cup molasses, 1 tablespoon of vinegar, 2 tablespoons of boiling water, ½ cup of butter. Boil ingredients together until the mixture will become brittle when tried in cold water. Turn into a well-buttered pan. For taffy, the following proportions give excellent results: 2 cups sugar, ½ cup of vinegar, 2 tablespoons of butter. Boil until the mixture will become brittle when tried in cold water. Turn on a buttered platter to cool. When cool enough to handle, pull.

TESTS FOR CANDIES, WITH CORRESPONDING TEMPERATURES

| STAGE | TEMP. | SIRUP TEST |
|---|---|---|
| Thread | 230 F.<br>110 C. | Forms a thread when dropped from a spoon |
| Soft ball | 238 F.<br>113 C. | Forms a soft ball when dropped into cold water |
| Hard ball | 248 F.<br>120 C. | Forms a hard ball when dropped into cold water |
| Crack | 290 F.<br>143 C. | Becomes brittle when dropped into cold water |
| Hard crack | 293 F.<br>155 C. | Becomes very brittle when dropped into cold water |
| Caramel | 360 F.<br>175 C. | Changes color and becomes very hard and brittle when cool |

## Serving Meals

It is not necessary for any housewife to burden herself with an attempt at elaborate table service, but it is necessary that attention be given to the dining room, the table and the food, in order that each may be made as attractive and pleasant as possible for the sake of the effect upon the minds and digestions of the members of the family. We easily understand how largely the appearance of our food and its service affect our appetite when we contrast a fresh, sunny room, clean table linen, a well-laid table and simple, well-

cooked fare with a stuffy room, a soiled cloth, dishes set awry and a general effect of flies, dust, and soggy, greasy food.

A certain amount of ceremony is desirable in table service, not only for its effect upon the adults, but for the training of the children in table manners. If time is taken each day for conversation at the table, for the proper serving of food, and for the observance of those niceties that we call "manners," there will be no awkwardness and no embarrassment when "company" comes. Girls who are our future homemakers should understand thoroughly the principles of good service even though it may not be practicable to use all of them every day. Every girl in her own home should consider it an accomplishment to serve for her mother without the assistance of a maid, and the mother who does not train her daughter thus is not doing her duty, for at some time in every girl's life she will feel the need of such training.

**Setting the table.** 1. The dining room should be kept scrupulously clean and neat. It should be well aired and the shades at the proper height.

2. Lay, first, the silence cloth, which may be made of canton flannel, an old blanket, or the regular padding sold for the purpose. It is used to prevent noise, to protect the table, and to make the tablecloth lie smooth.

3. The tablecloth should be large enough to cover the table and fall from 10 to 12 inches below the edge. A cloth which is too large is more expensive, harder to launder, makes an untidy appearance, and is in the way. Lay the cloth straight and smooth with the middle fold lengthwise down the center. When laundered, table cloths are often rolled on a round stick made for this purpose, which does away with all creases.

4. No table is really complete without some decoration. If a centerpiece or doily is used a simple design in white is best. We sometimes think that in a busy farm household it is impossible to have flowers on the table all the time, but in reality the country offers the best opportunity to have a pretty table all the year around if we but see the beauty at hand. The children will delight in arranging the flowers if the privilege is given them, and each season of the year will bring new offerings. In winter, bulbs may be bought for a few cents and grown with little trouble. Even this small cost can be avoided by bringing a few carrots or parsnips from the vegetable cellar, splitting them lengthwise and putting them in water in a warm room. In a short time, they will grow into a feathery green centerpiece for the table. In using any sort of a decoration on the table, it should be low enough so that everybody can see over it. Use a vase or bowl that is suitable for the flowers it is to hold, and do not crowd the blossoms.

5. The term "cover" means the space together with the china, silver and glassware allowed for each person. Allow 2 or 2½ feet for a cover. Place each piece of silver so that the end is about one inch from the edge of the table, and let each piece be parallel with the others. Nothing detracts so much from the appearance of the table as having the cloth, dishes, or silver helter-skelter wherever they chance to fall. Place the knife on the right side with the cutting edge toward the plate, the spoons to the right of the knife, and the forks, with tines up, at the left. There should be room between the knife and fork for any plate used during the meal. If more than one knife, fork, or spoon is used they keep the same position with reference to the plate, and are so arranged that the first piece to be used is on the outside of the space allotted. There is one exception to this rule. If raw oysters are served, the oyster fork belongs at the extreme right, since it is the first piece to be used.

The water glass is set at the point of the knife, the bread and butter plate at the tip of the fork. If butter spreaders are used they lie across the edge of the bread and butter plate with the edge toward the edge of the table. If the salad is to be served with the main course of the meal, the salad plate is placed at the left of the dinner plate. The napkin is laid at the left of the plate with the fold on the upper and left sides. The cup and saucer stand at the right of the plate.

**General rules for serving.** 1. Place and remove all individual dishes, such as the dinner plate, from the right, with the exception of dishes set to the left which must be removed from the left in order to avoid reaching in front of guests.

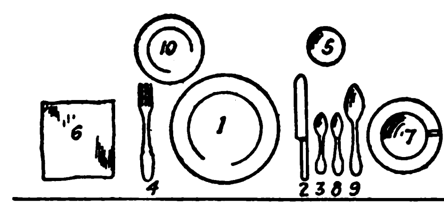



FIG. 161. A properly laid "cover"; 1, plate; 2, knife, cutting edge at left; 3, teaspoon (bowl up); 4, fork (end of tines up); 5, glass; 6, napkin; 7, cup and saucer; 8, spoon; 9, soup spoon; 10 bread and butter plate.

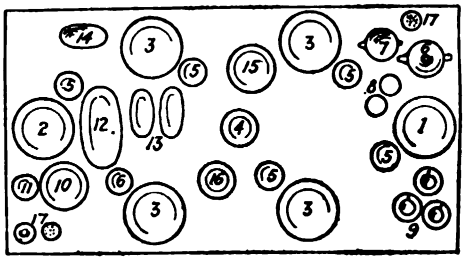


FIG. 162. Farm table conveniently arranged: 1, mother's place; 2, father's; 3, other members'; 4, flowers; 5, bread and butter plates; 6, coffee or tea pot; 7, milk or water pitcher; 8, cream pitcher and sugar bowl; 9, cups and saucers; 10, cereal or sauce; 11, small dishes for (10); 12, meat; 13, vegetables; 14, gravy; 15, bread; 16, butter; 17, salt, pepper, etc.

2. Use the right hand in placing and removing dishes from the right.

3. Dishes from which a person is to help himself should be passed at the left, with the left hand.

4. When passing large dishes, the waitress uses a folded napkin laid on the palm of her hand, although this is unnecessary when handling large, heavy meat platters. For small dishes, a tray with a white doily is used.

5. Glasses should be filled as they stand in place, or if this is inconvenient, draw the glass by the lower part to the edge of the table, using the left hand, and fill.

6. Never make a display of silver or china, or embarrass your guests by using a table service which they do not understand.

7. Remember that all rules for serving have been worked out for simplicity and convenience; adapt them to your conditions.

**Serving our own tables.** Good service is always possible without help if the menu is so planned that the hostess need not leave the table often. Guests are invited to visit, and when the hostess spends much of her time in the kitchen, or wears a worried look at the table for fear something is going wrong, she is not fulfilling her real duties. However, if the menu is selected with care, and all dishes are omitted which might keep her hot and busy at the last minute before serving, there is no reason why the woman of the house should not appear to her guests calm, composed and cool with a smile and pleasant conversation that are natural, not forced. The following menu, for example, may be easily served without assistance:

Roast meat, pickles, mashed and browned potatoes, buttered asparagus, jelly, rolls, butter, cabbage-pimento-and-nut salad, fruit-gelatin dessert, cake, coffee.

When the guests are seated, the water, butter, jelly, rolls, salad, meat, vegetables and bread will be on the table. At the right of the hostess, on the top shelf of a serving table, are the pitcher of water, the coffee percolator, cups, saucers, sugar and cream. On the lower shelf are the cake and dessert. The guests will assist by passing the coffee and the various dishes, and by passing the soiled dishes to the hostess at the end of the course. She places these on the lower shelf of the serving table as she transfers the dessert and cake to the dining table. All crumbs should be removed from the cloth before the dessert is served.

A menu so planned may be served easily, quickly, and without the necessity of the hostess leaving the table at all during the meal.

## Preserving Foods on the Farm

**Ten rules for canners.** (1) Select only fresh fruits and vegetables. (2) Clean and prepare them. (3) Scald or blanch as directed. (4) "Cold dip" immediately. (5) Pack in the jar. (6) Add salt to vegetables (1 teaspoon per quart jar). (7) Fill jar with hot water or sirup. (8) Adjust rubber and top, leaving the latter loose. (9) Sterilize the required time. (10) Remove from canner and finish sealing; do *not* remove top or rubber after sterilization.

FIG. 163. Canning and preserving may be done in a tightly covered washboiler, but the steam pressure cooker shown in the background, saves time and fuel.

**Special points.** (1) "*Blanching*" means immersing for the given length of time in boiling water. Count the time only while the water is boiling. (2) "*Cold dip*" means plunging immediately into cold water after blanching. (3) Keep the water boiling hard during sterilization. (4) Follow the time table (p. 205).

FIG. 164. Blanching is easily done in a cheesecloth bag.

**Canning poultry.** 1. Kill fowl and draw at once; wash carefully and cool; cut into convenient sections. Place in wire basket or cheesecloth, and boil until meat can be removed from bones; remove from boiling liquid and remove meat from bones; pack closely into glass jars; fill jars with pot liquid, after it has been boiled down one half; add level teaspoon of salt per quart jar of meat; put rubber and cap in position, not tight; sterilize as follows, according to type of outfit used: Water bath (homemade or commercial), 3½ hours; water seal (214 degrees F.), 3 hours; 5 pounds steam pressure, 2½ hours; 10–15 pounds steam pressure, 1 hour. Remove jars, tighten covers; invert to cool and test the joint; wrap jars with paper to prevent bleaching.

2. Kill fowl and draw at once; wash carefully, and cool; cut into convenient sections and pack at once into glass jars; fill with boiling water; add level teaspoon of salt per quart; put rubber and cap in position, not tight, and sterilize for 4, 3½, 3 hours or 1 hour, depending on which of the above-listed methods is used. Then remove jars; tighten covers; invert to cool and test the joint; wrap jars with paper to prevent bleaching. (U. S. Department of Agriculture recipes.)

FIG. 165. Pouring sirup into jars of canned fruits.

**Drying fruits and vegetables,** either in the sun or by artificial heat, is a very practical and economical method of preserving food. The second method is more rapid, more certain, and usually gives better results. Homemade driers are now being used with excellent results; they are cheap and easy to make and use.

Many of the products for which directions are given here may be dried either with or without preliminary blanching. In such cases, both methods are described. Alternative methods are designated by letters. In general, the directions are those recommended by the United States Department of Agriculture.

*Sweet corn.* Only very young and tender corn should be used for drying, and it should be prepared at once after gathering.

(a) Cook in boiling water 2 to 5 minutes, long enough to "set" the milk. Cut the kernels from the cob with a sharp knife,

CANNING TIME TABLE

| Product | Blanch or scald (minutes) | Add Salt (to vegetables) or Sirup (to fruits) | Time of sterilization | | |
|---|---|---|---|---|---|
| | | | Water bath | Water seal | Steam pressure (5 lbs.) |
| Asparagus | 3–5 | Salt | 1½ hrs. | 1¼ hrs. | 1 hr. |
| Beans (String or Lima) | 5–8 | " | 2 hrs. | 1½ hrs. | 1 hr. |
| Beets | 6 | " | 1½ hrs. | 1¼ hrs. | 1 hr. |
| Carrots | 6–8 | " | 1½ hrs. | 1¼ hrs. | 1 hr. |
| Corn | 8–15 | " | 3½ hrs. | 1½ hrs. | 1 hr. |
| Corn on cob | 8–15 | " | 4 hrs. | 2 hrs. | 1½ hrs. |
| Egg plant | 8–10 | " | 2 hrs. | 1½ hrs. | 1 hr. |
| Greens | 15–20 | " | 1½ hrs. | 1½ hrs. | 1 hr. |
| Okra | 5–8 | " | 2 hrs. | 1½ hrs. | 1 hr. |
| Parsnips | 6–8 | " | 1½ hrs. | 1¼ hrs. | 1 hr. |
| Peas | 5–8 | " | 2 hrs. | 1½ hrs. | 1 hr. |
| Peppers | 3 | " | 30 min. | 20 min. | 15 min. |
| Pumpkin | 10 | " | 1 hr. | 45 min. | 35 min. |
| Squash | 10 | " | 1 hr. | 45 min. | 35 min. |
| Sweet potato | 6–8 | " | 1½ hrs. | 1¼ hrs. | 1 hr. |
| Tomatoes | 1 | " | 22 min. | 18 min. | 15 min. |
| Apples | — | Thin | 20 min. | 12 min. | 10 min. |
| Apricots | — | " | 16 min. | 12 min. | 10 min. |
| Berries (Sweet) | — | " | 16 min. | 12 min. | 10 min. |
| Berries (Sour) | — | Thick | 16 min. | 12 min. | 10 min. |
| Cherries | — | Medium | 16 min. | 12 min. | 10 min. |
| Grapes | — | Thin | 16 min. | 12 min. | 10 min. |
| Peaches | — | " | 16 min. | 12 min. | 10 min. |
| Pears | — | " | 20 min. | 12 min. | 10 min. |
| Plums | — | Medium | 16 min. | 12 min. | 10 min. |
| Quinces | — | " | 20 min. | 12 min. | 10 min. |

FIG. 166. Handy slicer used in drying fruits and vegetables

taking care not to cut off pieces of the cob. Spread thinly on trays, and place in position for drying. Stir occasionally until dry.

(b) Boil or steam on the cob 8 to 10 minutes to set the milk. To improve flavor add a teaspoon of salt to each gallon of water. Drain well and cut corn from cob, using a very sharp and flexible knife. Cut grains fine, only half way down to the cob, and scrape out the remainder of grain, being careful not to scrape off any of the chaff next to the cob. Dry from 3 to 4 hours at 110 to 145 degrees F. When field corn is used, good, plump roasting-ear stage is the proper degree of ripeness. A pound of dried corn per dozen ears is an average yield.

(c) The corn may be dried in the sun after having been started in an oven for 10 to 15 minutes. Sun drying is not satisfactory in moist weather.

*String or snap beans*. All varieties of string beans can be dried, but only beans in ideal condition for table use should be selected.

(a) Wash, remove stem, tip, and "strings." Cut or break the beans into pieces ½ to 1 inch long, and place on trays and dry. They also can be run through a slicer and then dried quickly.

(b) Prepare as directed above, but instead of cutting the beans, thread them on coarse, strong thread, making long "necklaces" of them, and hang them above the stove or out of doors until dry. An old-fashioned recipe calls for boiling the pods until nearly cooked through before drying.

(c) Wash and string beans carefully. Very young and tender beans can be dried whole; full-grown ones should be cut in quarter-inch to one-inch lengths with a vegetable slicer or sharp knife. It is better to cut beans than

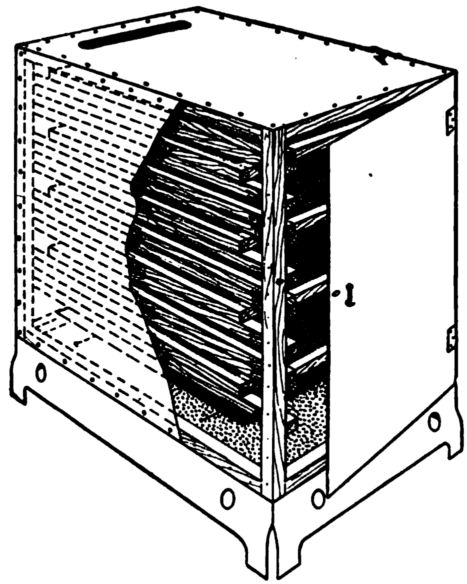


FIG. 168. Homemade dryer cut away to show construction. Note perforated metal bottom and trays alternately pushed back and pulled forward to allow currents of warm air to pass around them. (Farmers' Bulletin 841.)

to snap them. Put them in a bag of cheesecloth or in a wire basket, and blanch in boiling water for 6 to 10 minutes, depending upon their maturity. Half a teaspoon of soda may be added to each gallon of boiling water to help set the green color in them. Remove surface moisture by placing between two towels or by exposing to sun and air for a short time. Dry young string beans 2 hours, more matured beans 3 hours. Begin drying at a temperature of 110 degrees F., and raise it gradually to 145 degrees. Wax beans are dried in the same manner as the green string beans.

*Lima beans*. Lima beans can be shelled from the pod and dried. If gathered when young and tender, they should be washed and blanched for from 5 to 10 minutes. Re-

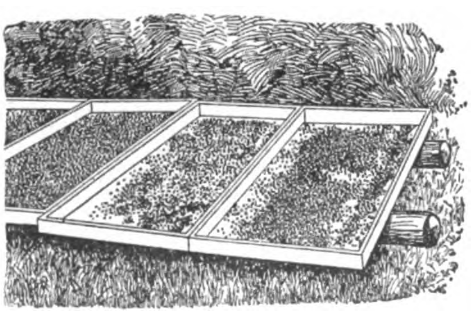
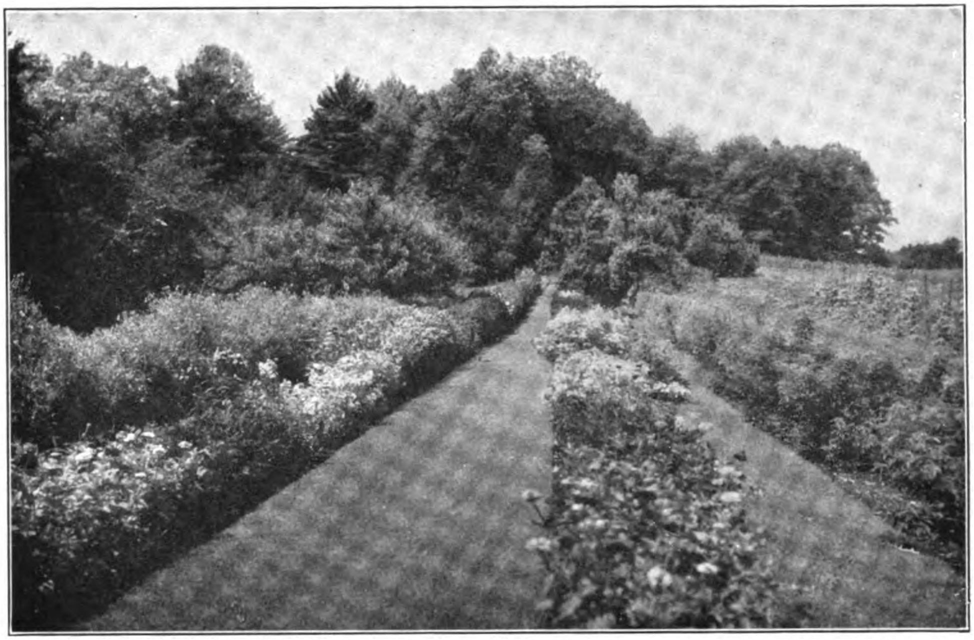
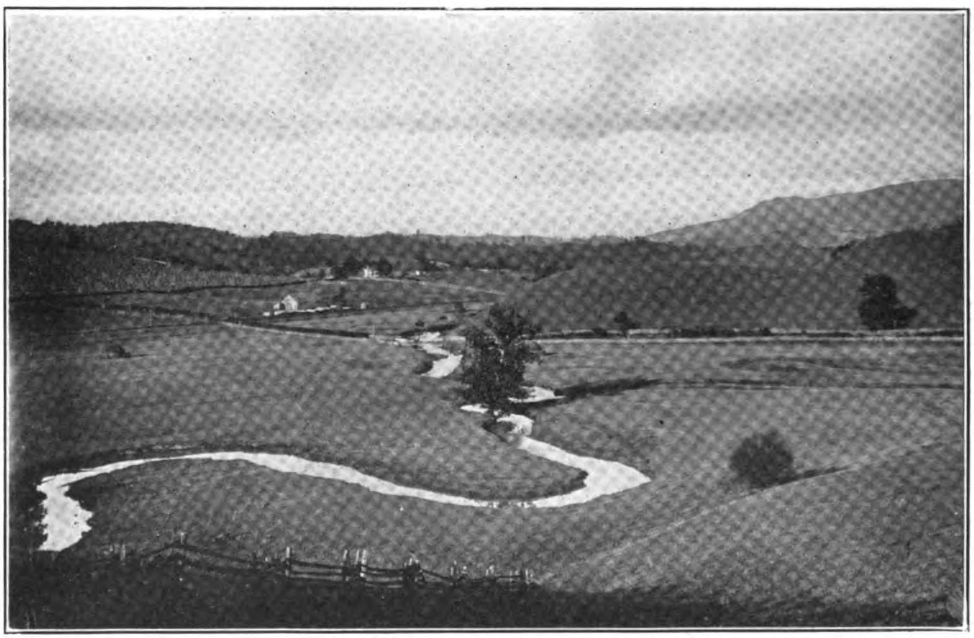


FIG. 167. Fruits and vegetables may be dried in the sun, if protected from insects

FIG. 169. Fruits and vegetables may be quickly dried in trays by means of an electric fan

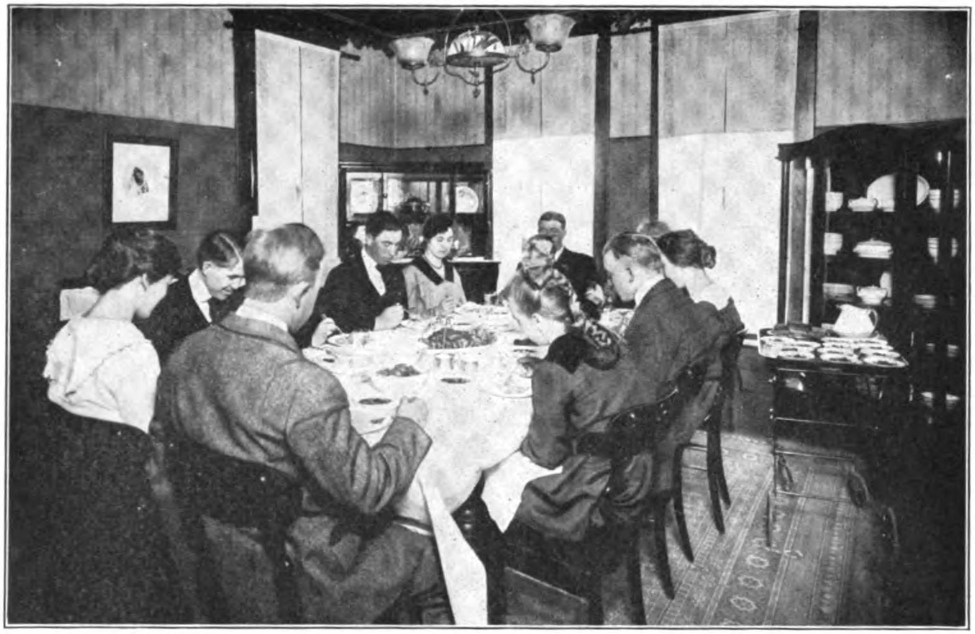


By wise use of native trees, shrubs, and flowers, the farmer can add to both the value and the livableness of his farm



The view of a fair countryside and its fertile fields is an asset which, in its fullest measure, none but a farm home can hope to enjoy

When Farm Life Proves Narrow and Unprofitable It Is Often Because the Business Side Has Smothered Out All Other Interests in Life



The problem of feeding the farm family is a difficult and constantly recurring one. System, family coöperation, and modern conveniences help to simplify it

If every farm woman were given as complete an equipment for her work as the average farmer has for his, there would be more happiness and fewer farm failures in the world

THE ONE-WOMAN FARMHOUSE IS EVEN COMMONER THAN THE ONE-MAN FARM. IT SHOULD BE EQUIPPED WITH EVERY LABOR-SAVING DEVICE AVAILABLE

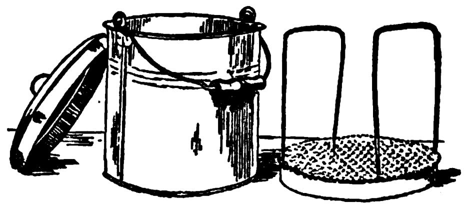


FIG. 170. Simplest possible type of home canner. The false bottom is necessary to prevent breakage of jars

move surface moisture, and dry from 3 to 3½ hours at same temperature as string beans.

*Okra.* (a) Small, tender pods are sometimes strung on a stout thread and hung over the stove to dry. If dried in that manner, heat in oven before storing on trays.

(b) Wash, blanch 3 minutes in boiling soda water, and dry 2 to 3 hours at 110 to 140 degrees F. Use half a teaspoon of soda to a gallon of water. Dry young and small, tender pods whole. Older pods should be cut in quarter-inch slices.

*Peas.* (a) Shell and spread on trays and dry.

(b) Shell full-grown peas, blanch them for from 3 to 5 minutes, remove surplus moisture, spread in single layer on trays, and dry from 3 to 3½ hours. Begin drying at 110 degrees F., raising temperature very slowly in about 1½ hours to 145 degrees F. Continue drying 1½ to 2 hours at 145 degrees F.

(c) Shell full-grown peas, pass through a meat grinder, spread on trays, and dry. Whole peas take longer to dry, but when cooked, they resemble fresh peas. The ground peas dry more quickly, but make a product which can be used successfully only in the preparation of soup or purée.

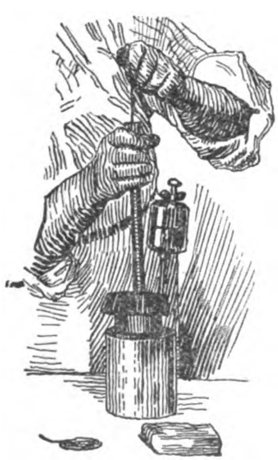


FIG. 171. Using one type of self-heating capping iron

(d) When drying the very young and tender sugar peas, use the pods also. Wash and cut in quarter-inch pieces. Blanch in boiling water 6 minutes. Remove surplus moisture and dry the same length of time and at the same temperature as string beans. It is not necessary to use soda when blanching peas.

*Cabbage.* (a) Select well-developed heads of cabbage and remove all loose outside leaves. Split the cabbage, remove the hard, woody core, slice the remainder of the head with a kraut cutter or slicer, and dry.

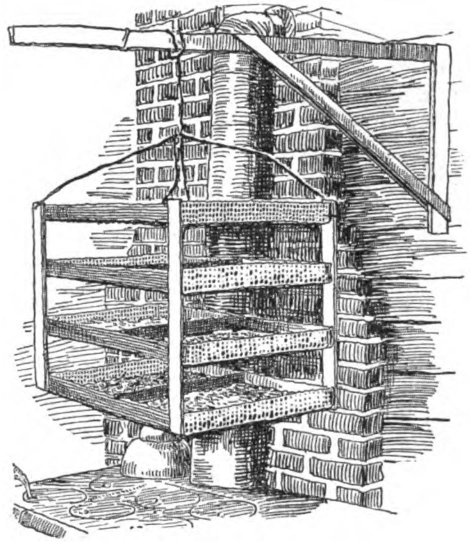


FIG. 172. Homemade wire drying rack suspended out of the way over the kitchen range

(b) Shred or cut into strips a few inches long. Blanch 10 minutes, drain, remove surface moisture, and dry 3 hours at 110 to 145 degrees F.

*Sweet potatoes.* Select sound, mature roots. (a) Wash, boil until nearly done, peel, and run through the meat chopper. Spread on trays and dry until brittle.

(b) Treat as above, but slice instead of running through the meat chopper.

(c) Wash, peel, slice, spread on trays, and dry. A somewhat brighter product will result if the sliced potato is dipped in salt water just before drying.

*Apples, pears, and quinces.* Early varieties and sweet apples are not well adapted to drying. Winter and fall varieties are much better.

(a) Peel, core, trim, and slice into quarter-inch pieces. Dip in weak salt solution (8 teaspoons of salt to 1 gallon of water). Spread on trays and dry. It is only necessary to dry apples long enough for them to become

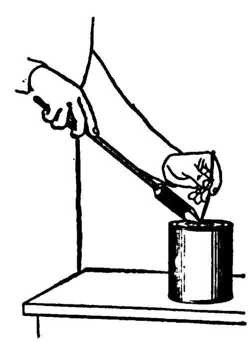


FIG. 173. Closing the vent hole in a can of vegetables with solder and soldering iron.

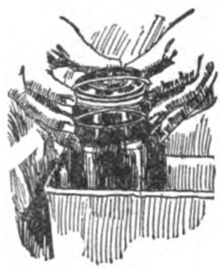


FIG. 174. In sterilizing leave the jars unsealed, like this—

tough and somewhat leathery.

(b) Pare, core, and cut into eighths, or core and slice in rings, using fruit or vegetable slicer. As apples discolor quickly, do not let them stand long before drying. To prevent discoloration as the fruit is prepared, it may be dipped for 1 minute in a cold salt bath, using 1 ounce of salt to 1 gallon of water. Remove surplus moisture and dry at 110 to 150 degrees F., raising temperature gradually. Dry from 4 to 6 hours, or longer if necessary.

Pears are dried in the same way as apples, or may be steamed 10 minutes before drying.

*Peaches*. Peaches usually are dried unpeeled, but they are better if peeled before drying.

(a) Remove the stones, cut the fruit into halves, or preferably into smaller pieces, and spread on trays to dry.

(b) Cut in halves, pit, lay in trays pit side up, and dry at same temperature and for same length of time as apples.

FIG. 175.—Until ready to remove them from canner. Then snap tops down.

**Food supply suggestions.** (1) Bear in mind the various sources you have for your food supply, and make use of each source at the proper season. (2) Compare the cost and quality of home-prepared products with the commercially prepared. (3) Purchase the food supplies needed in large quantities whenever a good storeroom is available. (4) Plan meals at least a week in advance. (5) Prepare the exact amount of food needed; some foods cannot be warmed up or made over. (6) Plan meals to utilize all leftovers—stale bread, fats, meat scraps, bones from roasts, etc. (7) Stint the garbage pail as much as possible.

# C. FARM FURNISHINGS AND FARM SEWING

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## Household Furnishings—Their Choice and Care

(*By* MRS. HELEN JOHNSON KEYES)

House furniture and ornaments have been discussed in Chapter 10, and labor-saving household tools earlier in this chapter. There remain to be considered: (1) Beds and bedding, (2) household linens, (3) table ware.

### Beds and Bedding

**Bedsteads.** Metal bedsteads have been popular for many years, chiefly because they are so easily kept clean and odorless; they can be washed with soap and water or even burned clean with coal oil. Brass beds are proof against almost any injury except dents, and those of enameled iron and steel can be renewed with an occasional coat of paint. Steel bedsteads are a little more expensive than iron ones, but they are stronger, and being lighter, are more easily moved and with less injury to floors. They come in designs more like those of brass beds, many of which can not be copied in iron, and their enamel finish is more permanent. When either steel or iron beds are trimmed with brass knobs and rods, these should be heavy and of good

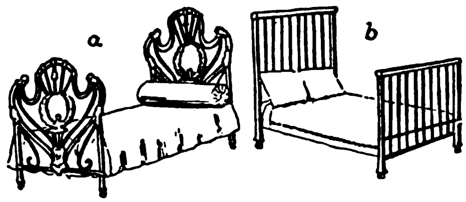



FIG. 176. Undesirable (*a*) and desirable (*b*) types of metal bedstead. Simplicity is always desirable

quality; otherwise they will soon dent and bend.

Let those, however, who can not replace the wooden beds which are theirs already, comfort themselves with knowing that these have a quaintness and charm which metal beds never acquire, and may be kept just as sanitary by the spending of a little more time upon them.

Each sleeper should have his or her own bed. This means improved health and the good temper which comes from refreshing slumber.

**Springs.** It is worth while to buy a good spring if it can possibly be afforded. We spend more than a third of our lives in bed, and on our comfort during sleep and the healthful postures in which we lie, our health depends. The best springs are the box spiral or woven wire types with a sufficient number of spirals in the middle to prevent sagging. There are cheaper springs than these, however, from which one may expect satisfaction, and for which "boxes" or covers may be made at home of unbleached drilling and fastened to the underside by a lacing running through brass rings or buttonholes. This box increases greatly the durability of the spring, by keeping it from twisting and working crooked. Also it protects the mattress from rust. It can be removed for washing.

**Mattresses.** Feather mattresses, though much used on farms, are now known to be actually unhealthful both in winter and summer, for young and old. They cause the sleeper to perspire, and yielding freely to the weight of the body, they allow it to get into unwholesome postures.

The best mattresses are therefore of hair; they can be bought in many different grades, at varying prices. Felted cotton is cheaper than hair, very comfortable, and easily done over when it becomes lumpy. Mattresses made of excelsior, corn husks, or even wood shavings, though certainly not soft and luxurious, are to be preferred to feather beds, since they are much more likely to promote the health and energy of young people.

The same general considerations apply to pillows.

Mattresses and pillows should be completely encased in covers of light cotton stuff. Otherwise, the ticking will soon become soiled, and dust will gather on the underside of the mattress. A pad made of old cotton blankets with two or three layers of cotton batting or of newspapers, is a further protection to the top of the mattress.

**Coverings.** Blankets made of wool filling on a cotton warp are the very best coverings; they are warm without being heavy, and they wash and wear beautifully, even better than the more expensive all-wool blankets.

Homemade quilts and comforters are an economy, for they are made of odd pieces of cloth and in odd scraps of time. If the pieces which are combined are of the same kind of material, with similar designs, the effect is very pretty.

Blankets should be covered by a dimity, or calico sheet drawn over them under the counterpane and left on all night when the counterpane is removed. The top of the quilts ought to be kept clean by means of an envelope of calico or similar material, buttoned on or caught with thread, so that it can be removed frequently for washing.

## Household Linens

Sheets, pillowcases, towels and table damask continue to be called household linen, although linen has risen to such prices that it has been replaced very generally by cotton and will not be considered at all in this chapter. These are articles on which it is possible to waste or save a considerable sum each year.

**Buying.** The question whether household supplies shall be bought readymade or the material bleached, cut, and sewed in the home, is one which every housekeeper must

BUYING vs. MAKING AT HOME (1917 FIGURES)

| If bought | If made | Saved by making |
|---|---|---|
| *Sheets*, bleached, seamless, plain hem 72 x 86 inches. Each 90 cents. Dozen $10 | Unbleached cotton sheeting, 36 inches wide; 10-yard bolt $1. | 40 cents per sheet |
| *Pillow cases*, ready made, to match sheets, 22 x 32 inches. Pair 50 cents | Same quality as sheets, 22 x 32 inches. | 10 cents per pair |
| *Towels*, hemmed huck, 35 x 18 inches. Pair 40 cents | Bleached cotton huck, 17½ inches wide; per yard 15 cents | 10 cents per pair |
| *Table cloths*, cotton damask, 58 x 100 inches; 50 cent quality. Per cloth $1.75 | Bleached or colored damask, 58 inches wide; per yard 50 cents | 25 cents per cloth |
| *Napkins*, 18 x 18 inches, per dozen $1.25 | Material to match | 25 cents per dozen |

decide for herself according to the time at her disposal and her strength. It must not be forgotten that economies cost too much when they wear out the body and spirit of those who employ them, or when they lead to the neglect of the children and of all educational and social interests. In any case, the question can not be intelligently answered without a comparison of the cost of the finished products with the cost of the materials alone. Prices change so constantly that the data on page 211 can only suggest the saving which may be accomplished by home work under conditions that sometimes exist.

## Making and Mending Home Furnishings

When making articles using more than one breadth, be careful that the cloth runs the same way in all of them; otherwise the seams will pucker when washed. It is wise to pin the top of the material to an old sheet and, as fast as the breadths are cut off at the bottom, to pull the material to the top again and pin it there. If they cannot then be basted at once, they can be folded away pinned.

Seams are a weak spot and, unless made generously wide, will certainly pull and fray.

Sheets ought to be wide and long enough for thorough tucking in, or for making a bed hospital-fashion in case of illness (p. 236). A firm sheet not only insures the comfort of the sleeper, but is subjected to less wear and tear itself, because it escapes the pulling, slipping, and wrinkling which a loose sheet undergoes.

There is economy in leaving open both ends of a pillowcase, for the thrust of the flatiron against the double end soon wears it out; such a wear is hard to mend except by shortening the case, which cannot always be done. Buttons and buttonholes at one end or both ends give a dressy appearance which does away with the necessity for shams

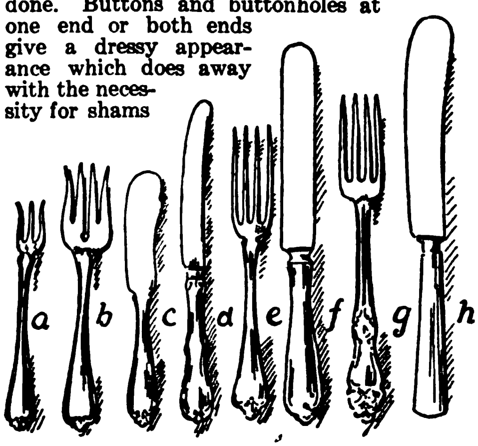



FIG. 177. Flat silver, illustrating some attractive, artistic designs and different types of utensils. (*a*) oyster fork; (*b*) salad fork; (*c*) butter spreader; (*d*) fruit knife; (*e*) tea fork; (*f*) tea knife; (*g*) dinner fork; (*h*) dinner knife.

Hemstitching, beautiful trimming though it is, weakens the material to a degree which is practical ruin. On this account, featherstitching across sheet hems and cross-stitching along the hems of huck towels are to be preferred. The cross-stitch may be worked in colors and angular designs with fine effect. If lettering is placed on cross-stitched towels, it should be done in cross-stitch in the form of detached or running letters. Otherwise, satin stitch (p. 225) is the handsomest for initials and monograms.

Fringe grows shabby almost at once and is to be avoided on all articles which must be washed. Suitable lace edgings are better.

Nice table damask should always be hemmed by hand; machine stitching will spoil the appearance of the handsomest damask. The so-called French hem is neater than the ordinary one for this purpose. To make it, turn the material up, away from you, the width you want, folding in the edge, of course; then double it back to the same width and crease it. The single and the double edges are then overhanded closely, at the top. When finished, the hem is pressed down to lie like an ordinary hem, with the sewing at the bottom. The narrower it is made, the better.

**Mending.** The art of making things last a long time consists of mending them the moment a rip, tear, or break occurs. Really, mending should be done before washing, but the task is neither agreeable nor ordinarily practicable in the midst of the family circle.

When sheets tear in the middle, rip them down their lengths and sew the outer selvage edges together, hemming, for the outer edges, the frayed parts which were inside.

## Table Ware

**China.** Dinner and tea sets may be bought at reasonable prices in handsome designs. "Open stock" should be chosen, that is, sets, the pieces of which will be sold separately, so that broken dishes can be replaced. Designs should be flat and "conventional," not rounded out like real flowers. If we are to consider good taste, pressed and near-cut glass are less desirable than simple bowls, jugs, and dishes of pottery or china, because the former are not what they pretend to be.

When china becomes stained with yellow, it may be cleaned, before washing, with a damp cloth rubbed in dry salt, wood, or coal ashes.

**Silver.** Solid silver is always seen in simple designs, and plated ware which follows this good example is better looking and more dignified than that which is ornate. Each pattern has its name, and it is desirable to keep all the small silver of the same design. Reinforced, triple, and quadruple plate are all reliable and permanent. Nickel silverware, is a composition and is injured by acids and fats if exposed to them for long.

## Clothing the Farm Family

(*By* MARY ELIZABETH ROBINSON)

Clothing the farm family correctly and economically is just as important as feeding it rightly. The country woman should first decide whether the family clothing is to be made in the home or purchased ready-to-wear. In either event she should have a knowledge of choosing textiles, designing garments and making them.

The first important step is to gain a knowledge of the textile fibers, which may be classified as: (1) *Vegetable*—Cotton, linen, jute, hemp, ramie. (2) *Animal*—Wool, silk, hair. (3) *Mineral*—Asbestos. (4) *Artificial*—Luster, cellulose, gelatin silk, metallic threads, spun glass. Without a thorough knowledge of these fibers the woman is helpless when it comes to making the proper selection of clothing. She should be able especially to distinguish between the four common fibers—cotton, linen, wool and silk. Linen, silk and wool are often adulterated with cotton, the cheapest fiber; the resulting materials may wear better than the pure fiber, but the disadvantage is that the purchaser is paying linen or silk or wool prices for cotton.

The characteristics of the four fibers most commonly used in clothing and household textiles are:

**Cotton.** (1) Inexpensive; (2) strong and elastic; (3) good conductor of heat; (4) dyes easily; (5) launders easily; (6) not easily affected by heat or alkali; (7) easily affected by acid; (8) absorbs moisture and gives it up slowly.

**Linen.** (1) Strong and durable; (2) launders easily and leaves no lint; (3) snowy white when bleached; (4) smooth and glossy when laundered; (5) good conductor of heat; (6) wrinkles easily; (7) not easily affected by acids; (8) water readily absorbed and evaporated; (9) does not retain stains as persistently as cotton.

**Wool.** (1) Difficult to launder; (2) not a good conductor of heat; (3) readily affected by heat and sudden changes in temperature; (4) elastic; (5) readily affected by friction; (6) absorbs a large amount of moisture, especially in damp weather; (7) very kinky, with scaly structure.

**Silk.** (1) Absorbs moisture readily; (2) poor conductor of heat; (3) readily affected by friction; (4) scorches easily; (5) careless washing destroys gloss; (6) strong and tenacious; (7) wears well (when pure); (8) soft and light in weight; (9) easily injured by high degree of heat or sudden change of temperature; (10) easily dyed; (11) absorbs moisture readily.

**Textile tests for purity.** The laws of our country offer no protection to the purchaser of materials. Therefore to protect themselves, women should know a few practical tests to determine the content and value of materials. The object in making these tests is to discover if cloth is adulterated, artificially dressed or misrepresented in any way.

1. If water is dropped on linen goods the moisture spreads rapidly, but if dropped on cotton it will remain unabsorbed for some time. This is not always a safe test as cotton and linen are often heavily "sized" with dressing which prevents the water from being absorbed.

2. A much safer test may be made by drop-

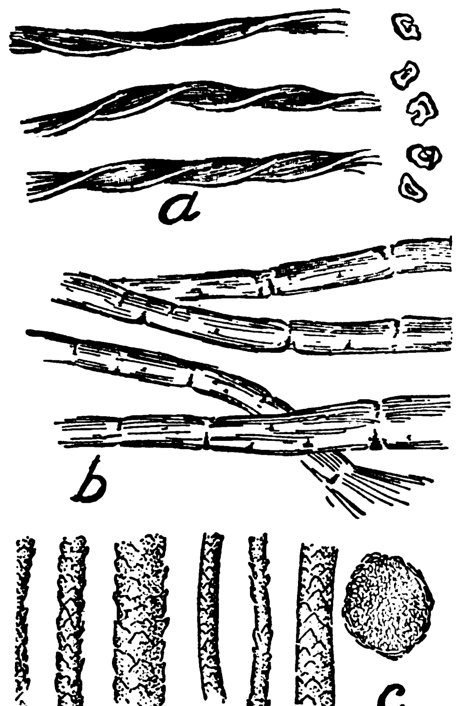



FIG. 178. Textile fibers greatly enlarged: (*a*) silk; (*b*) cotton; (*c*) wool

ping glycerin on the cloth. Linen will become transparent but cotton will not be affected.

3. When crushed in the hands, linen wrinkles more than cotton.

4. Cotton and wool mixtures, when moistened, wrinkle more than pure wool materials.

5. Material may be tested by pulling out threads and examining the ends. Cotton fibers are short, with fuzzy ends; linen fibers are long with uneven ends, usually pointed; wool fibers are short, kinky and stiff; fibers of reeled silk are long, straight and lustrous, while fibers of spun silk are short and easily broken.

6. Sizing may be discovered by rubbing the material between the hands to see if the "dressing" will come out. Washing will also remove dressing.

7. Each fiber has a characteristic burning test as follows: (a) Cotton burns quickly with flame. (b) Linen burns like cotton, but is not as inflammable as it has less oil in the fiber and less air in the woven cloth. (c) Wool burns slowly, gives off an odor like burnt feathers, and leaves a gummy residue. (d) Silk burns more slowly and with less odor than wool, and leaves a crisp ash. Silk leaves even more ash when weighted.

**Textile tests for strength.** *Yarns and threads.* Single yarns are not so strong as those where 2 or 3 threads are twisted together. Ravel goods and find out how many threads are combined. Yarns and threads are stronger, also, when combed so that their fibers lie side by side, instead of crossing irregularly. An examination of ravelings will show how the strands lie.

*The weave.* Under a magnifying glass count the number of threads to an inch which run in each direction—warp and woof. The higher the number the stronger the cloth. Then hold the cloth up to the light to see if the threads are close together and of the same thickness. Rub the thumb across the weave. If the weave is loose the thumb will leave a pathway of separated threads, and the material will not wear well.

*Is the cloth elastic?* If a material is elastic it will not wrinkle and it will drape well. To find out, crumple the goods in the hand; if, when released, the goods spring up, it has the desired quality.

*Is the material "weighted"?* In order to give body and weight, and to conceal loose and flimsy weaves, materials are very often weighted. In the case of cotton goods starch is most frequently used. To find out, tear the goods quickly; if dust flies, weighting is present.

*Is it strong enough to keep its shape?* Grasp the cloth with both hands about an inch apart and pull steadily. Do this in both directions. Cloth is only as strong as its weakest point.

**Tests for woolen and worsted goods.** *Are the short fibers, called flocks, well worked into the goods?* Brush the back of the material with a stiff broom. If short fibers are loosened, the flocks are not well worked in and the cloth will soon become shabby.

*Will the cloth wear shiny?* Wet the thumb and rub it *against* the nap. If the nap seems to stand up and resist, it will not wear down easily. Thick, short fibers are durable; long, loose ones are not.

**Tests for permanence of color.** *Are the colors "fast" against light?* Boil a sample in soapsuds for 20 minutes, putting a piece of white cloth in at the same time. If the white cloth is stained, the color is not fast against washing.

*Are they "fast" against rubbing?* Rub a dry sample briskly against white goods.

*Are they "fast" against rain and dust?* Sprinkle a sample with water in which is a little lime. Dry and then brush it. If the brushing shows up spots, the color will not prove fast against rain and dust.

## The Hygiene of Women's Dress

It is evident, judging from the modern dress of women, that the hygiene of dress has not been given serious consideration. Clothes are worn—or should be worn—first, to maintain a constant body temperature; second, to protect the body from heat and cold. Comfort and adornment should also be considered in the selection and choice of clothes, as should occupation, climatic conditions, state of health and age of the individual. Most of our modern styles fail to meet these requirements, although a good many women are adopting sensible, practical styles. No individual can afford to disregard fashion entirely, but any one can select healthful, comfortable, artistic and appropriate clothes.

A most important function of clothes is to aid the body in maintaining a constant temperature. The healthy body must always maintain a temperature of about 98.6 degrees, regardless of surrounding conditions. When the throat, arms and ankles are exposed in cold weather, the body wastes energy, and no individual can afford this waste, especially if the diet is deficient, as is often the case with young girls. Resistance to infection

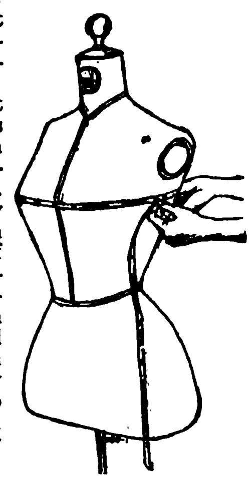


Fig. 179. Correct method of taking bust measure on a dress form.

by various disease germs is lowered by exposure to severe cold. Thus, in cold weather, the amount and character of the clothing should be changed in order to diminish the heat loss of the body which is regulated chiefly by controlling the evaporation and radiation from its surface. This can be accomplished in part by the use of proper clothing, since clothing of any kind holds a layer of warm and moist air between it and the skin, thus diminishing both evaporation and radiation.

**Underwear.** A close relationship exists between the regulation of bodily temperature and the kind of underwear worn. *Woolen* underwear would be ideal for winter were it not for 5 facts: (1) It is very difficult to keep clean. Wool fibers, owing to their structure, absorb the sweat and oily secretions of the skin and hold them, and bacteria thrive in woolen underwear. (2) Wool does not absorb or give up moisture rapidly. (3) Strong soaps and boiling water cannot be used in washing wool. If woolen underwear is laundered carelessly, the fibers mat, the air spaces are closed, and the garment loses its feeling of warmth. (4) Some persons cannot tolerate wool next to the skin on account of its irritating properties. (5) Woolen underwear is expensive.

Wool mixed with cotton or silk makes good underwear, especially for aged people, children and invalids.

*Cotton* underwear is more generally used than any other kind. When woven with an open mesh, cotton acquires a feeling of warmth, the large air spaces making it resemble wool. More dirt clings to cotton than to linen, but cotton launders easily and hence is a very sanitary material. Cotton underwear has from 15 to 30 per cent more heat than linen. In a close, tight weave, cotton is a good conductor of heat, which is the reason a garment of this kind feels so cool in summer. It is cheap, very durable and easily laundered.

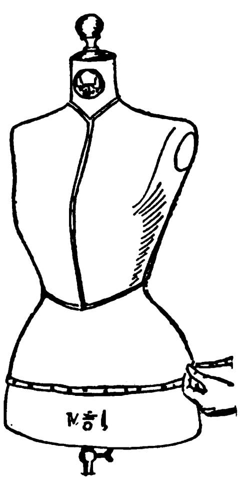


FIG. 180. Unless the dress form is of the right dimensions it is liable to give more trouble than help.

*Linen* underwear is more expensive than cotton. It is used in very warm countries. The chief objections to it are that it (1) may cool the body too quickly, (2) musses easily, and (3) does not last as long as cotton as it frays on the edges.

*Silk* underwear loses its moisture more rapidly than wool and therefore is more sanitary. For those who cannot wear wool next to the skin and to whom cost is no consideration, silk is an excellent material for undergarments. It is more easily cleaned than wool; and being light, though warm, it takes up little space.

The subjects of personal hygiene (bathing, etc.), and hygienic underwear should be considered together in order to get the best results and maintain good health.

**Outer garments.** Simplicity in style of dress adds to the attractiveness of both girls and women. In determining the style most becoming to the figure, pay careful attention to the length of the waist, the bust measure, the hip measure and the length of the skirt; for example, a tall figure with a short waistline may be improved by a dress with a longer waistline. In this way a figure out of proportion may be concealed, or its defects may be corrected. When the most becoming type of dress has been selected, both house and street dresses should be modeled along this general plan. Economy of time and labor in both planning and making may be practised in this way. Then, too, only one style of underclothing is required. A great deal of time may be saved in designing a garment by buying patterns of firms that make the proportion of figures as well as fashion a study.

**Accessories.** These may be listed as follows: Collars, cuffs, ties, belts, girdles, scarfs, nets, parasol, fan, hairpins, and combs. Without them the wardrobe would be incomplete, although the modern woman in many cases spends too large a per cent of the cost of her clothing here. In selecting an article for this part of the wardrobe consider especially: (1) the need for its purchase; (2) the use to which it will be put; (3) its durability; (4) its suitability to the wearer; (5) its cost in relation to the income.

## A Few Hints for Home Sewing

(*By* WINIFRED BUCK)

One who sews well can often make over and remodel her clothes for years, provided they are made of good material. Spring is the best time to get a suit, and a ready- or tailor-made one is always more satisfactory than a homemade one. A wise choice is of black or navy-blue serge, as these colors and this material not only wear splendidly, but always can be matched. Two months' wear will probably be gotten out of such a suit the first spring. The following fall, by ripping out the lining of the coat, putting in an interlining of cotton batting, and replacing the outer lining, the suit is made warm enough for winter.

The next spring the interlining is taken out. If the outer lining is worn under the arms, it can be patched—and matched—by cutting off the sleeve lining about halfway between

the elbow and the shoulder and using that to mend the body of the lining. The absent part of the sleeve lining can be replaced by any kind of material, as it will not show.

At this time the suit will probably need no other alteration, but if one is tired of it, an easy and pretty way to change it is to put on a collar and cuffs of some contrasting color in cloth, silk or velvet.

The second fall the suit will probably need a new lining; perhaps an old silk dress or an old skirt of alpaca or sateen can be used. However, a new cotton lining will not cost much and should be preferred to material of doubtful strength. The cotton-batting inter-lining, having of course, been saved, can be replaced. The suit will also need cleaning and pressing and, perhaps, new buttons. The skirt, if it is a long one, will be worn at the bottom and should be turned up. The worn part may be covered with common dress braid.

By the beginning of the third year, the suit will certainly need alterations on account of the changing styles. If the change needed is to make the skirt narrower, remove a breadth or straighten the breadths if they flare at the bottom. If the skirt is circular and the new fashion calls for a gored one, it must be ripped and the paper pieces of the new pattern pinned upon the material and the whole thing cut out as if new.

If a narrow skirt needs considerable widening, it will be absolutely necessary to insert extra material, and here the choice of an easily matched material proves its value. The coat usually needs no alteration except lengthening or shortening. It can be lengthened prettily by adding a band of dull black satin 4 inches or more wide and by repeating this on the bottom of the skirt and on the collars and cuffs.

A good suit, even after 3 years' wear, will still have much durable material in it which should provide at least one little girl's dress. The skirt will cut advantageously as a one-piece, pleated dress with either kimono or set-in sleeves; and a dress with sleeves, yoke, waist, and skirt for a tiny girl, or a wee pair of trousers may be gotten from the coat and scraps from the skirt. Before cutting up an old suit for the children, wash and press it, and make the new garments with the inside out.

It is a good plan to make two working dresses of exactly the same material. After a year of hard wear and constant washing, the waists of these dresses will be worn out, but by making a waist out of the skirt of one and attaching it to the skirt of the other, a work dress can be obtained which will last several months more.

In buying a silk dress, figure on using it by and by for a coat lining or a shirt waist. Or let this dress sometimes be of black satin, chiffon cloth, or georgette crêpe, for these materials not only wear well themselves, but are invaluable to combine with other goods when making over a garment. It is a good plan to get a little more silk than is needed at the moment, for use in future alterations.

When a garment is to be thoroughly remodeled, it is best to rip, brush, and clean it, pick out the old stitches and press it. Then fasten the pattern upon it and cut out the new dress. This is a little more troublesome than making a dress of new material, but when it is done it will look almost like new. Unless the material is fresh and strong, however, it will not be worth all this trouble. More frequently some trifling alteration will be all that the costume needs or is worth. If sleeves are too short, they can be lengthened by a cuff matching or contrasting with the suit. Skirts can be lengthened either by letting down the hem and facing it, or by making a yoke at the top. If the skirt is lengthened by letting down the hem, and there are worn places where the bottom of the skirt used to be, a small, carefully measured tuck can be taken just above the worn places and made to lie over them. Sometimes a skirt gets worn thin on the hips where the elbows rub. In such a case a yoke can be made at the top of the skirt, from extra material if available, from the pieces cut from the skirt gores, or from black satin, starting at each side of the top breadth in doing this. If black satin is used, this material should be repeated on some other part of the dress.

To mend a hole, pull out threads from the seams or hem and darn the hole with them. A hole darned with thread which does not match the material looks badly.

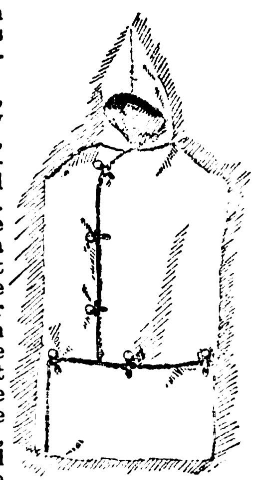


FIG. 181. Baby bunting wrap (see p. 218)

In making dresses, one must know how to sew well by hand, even though a machine is to be used for all long seams. Do not try to make a garment without a pattern. Spread out the material on the dining-room table or on a clean sheet on the floor. Have plenty of pins at hand. Arrange the different parts of the pattern on the goods, so that none of it will be wasted. When the pattern pieces are all arranged satisfactorily, pin them firmly to the goods. Then cut around them with a large, sharp pair of scissors. Allow for generous seams and hems which make alterations easier by and by, and give the garment strength.

The edges of the newly cut-out pieces should be laid together accurately and firmly basted with stitches not longer than half an inch. A friend will then be needed to help in fitting unless a form (p. 218) is used. Provide her with pins so that she can fasten firmly the seams she lets out or takes in. After removing the garment, put basting stitches in place of the pins; then sew it on the machine and try it on again.

A popular fashion is for waist and skirt to be fastened to an inside belt. This belt should be fitted and have hooks sewed on it before the waist and skirt are attached. After the waist and skirt are firmly sewed to the belt, the armholes should receive attention. They are important, for if they do not fit well the comfort and appearance of the dress is spoiled. The sleeves are next placed, tried on, and finally sewed.

The turning up of the skirt hem, the placing of the outside belt, and the finishing of the neck and cuffs are the final acts in making a gown.

A good general principle is that it never pays to spend much money for altering a very old gown.

Always save bits of unworn lace, fresh silk, hooks, snaps, buttons, collar wires, etc., but particularly pieces of material used in the dresses. They will all be useful for freshening up some old garment, and their use will save more money than is usually realized.

## Infants' Clothing

The importance of infants' clothing cannot be overestimated. The new-born babe is not able to select its own clothing, nor is it able to say when it is uncomfortable. Therefore, the mother should know how to vary the clothing with the season of the year in order to maintain the body temperature. Accordingly, unless there is a knowledge of fabrics, many babies will be kept too warm or too cool.

Wool is the best fabric for conserving heat, because of the air spaces between the fibers. Cotton flannel is warmer than plain cotton material for this same reason, but with repeated washings it tends to lose its woolly character. An all-wool fabric is undesirable because of the shrinkage when laundered. When combined with silk or cotton, the shrinkage is prevented, and, too, the material forms practically as good a non-conductor of heat as pure wool.

Recently women have begun to realize that the plain substantial garments are better for children of all ages than the much-trimmed garments, formerly used. Especially is this true of clothing for babies. In the first place, a well-fitting, simple design gives the freedom of movement necessary for free breathing and circulation. Garments too large, as well as those too small, are uncomfortable; trimmings, such as tucks, ruffles, embroideries and laces, cause unnecessary work for the mother, and fret the baby; extremely long dresses are being practically abandoned, since they serve no purpose whatsoever. Rompers are especially recommended when the child begins to crawl or walk.

Clothing for all ages should be made so that it is an easy matter to dress the child. The dressing of a baby can be simplified by using "Gertrude petticoats," which fasten on the shoulder, and slips opening entirely down the back. If the proper thought and care is taken in the older children's clothing, many children would be enabled to dress themselves at a comparatively early age, thus assisting the mother very materially.

In preparing an infant's wardrobe, the number of garments and the choice of fabrics will be governed by the amount of money which the mother wishes to spend. If materials are bought in quantity and the sewing is done at home, the cost need not be prohibitive. The following list is the smallest possible number of garments the baby will need:

3 Skirts of wool and silk, or wool and cotton. The ready-made ones fit and wear best. Size No. 2, with long sleeves, should always be selected.

3 Bands (Abdominal) of wool, or wool and cotton mixture. Size 6 or 8 by 20 inches. No hemming and no ravelings. Ready-made knit bands may be substituted for these if there is actual need, after the navel cord has come off.

4 Petticoats of wool and silk, wool and cotton, or cotton flannel. Make garment to open on the shoulder in order that arms will not have to be put through the armholes. Finish seams on right side. Length, 27 inches.

3 Night gowns (if worn by very young infant instead of dresses, at least 6 will be needed) of cotton flannel, made to open all way up back, and with sleeves long enough to cover child's hands. Length, 27 inches, unless tape is used to draw up bottom, when it should be 30 inches.

8 Slips of nainsook, crêpe or soft linen, made to open all way up back, and with no trimming around neck. Length, 27 inches.

48 Diapers of cheap cotton flannel, with soft pad which may be burned. Size, at first 24 inches, later 27 inches square; pad 8 by 6 inches.

FIG. 182. A well-lighted, well-equipped sewing room where work can be left undisturbed, is a valuable feature of the farmhouse.

**2 Cloaks and capes**, one for winter of eiderdown or soft wool lined; one for summer, cashmere lined with silk. Baby bunting wrap (Fig. 181) is style preferred.

**3 pairs stockings**, wool and cotton for winter; cotton for summer. Size 2.

**1 pair shoes** to be used when baby begins to play on floor. Must be broad enough for free exercise and use of toes.

## Sewing Equipment

A well-made garment requires well selected and substantial sewing equipment which, to render the most efficient service, should be kept in one certain place in the house. Every woman knows what a comfort it is to find her sewing just as she left it when she was called away to some household duty. A room, light and conveniently located, should be provided for when building a new house. However, since most homes have no room of this type, a portion of a hall or bedroom usually must and should be set aside for the sewing work.

*Essential Sewing Equipment*

- Sewing machine with attachments
- Cutting table
- Skirt gauge
- Ironing board and iron
- One yard of pressing canvas
- Small bowl for holding water
- Yard stick
- Sewing box or basket, containing shears, small scissors, emery, tracing wheel, stiletto, thimble, tape line, needles, pin cushion, pins.

For a somewhat more elaborate equipment, add: Dress form, wardrobe, wrapping paper, leveling table, and ripping knife (safety razor blade preferred).

Fig. 183. A homemade dress form, padded to meet the requirements of the individual.

**The homemade dress form.** Without a dress form a woman is almost helpless when it comes to doing her own fitting; often a garment is put away unfinished after the woman's patience is exhausted. But most of the reliable dress forms on the market are beyond the purse of the average housewife; and, if one can be bought, it is difficult to find a form which can be used without some alteration. Like commercial patterns, dress forms are made according to average measurements, and few women happen to be average in every particular.

The most efficient and, on the whole, a most easily made form is the padded type

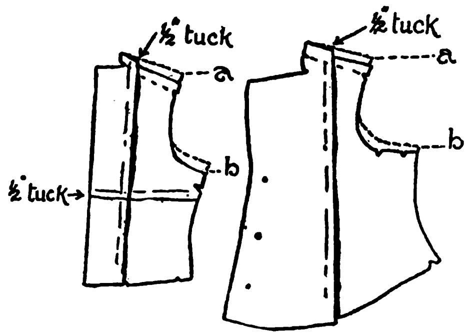



Fig. 184. How the waist pattern may be altered without affecting its lines

based on a purchased foundation dress form. In selecting this, take care to get one small enough. The hip and bust measures must both be taken into consideration as well as the thickness of the form in comparison with that of the individual. A very good rule is to purchase a form 2 sizes smaller than the bust measure. Misses' forms are best as the bust and waistline are not so marked as in ladies' sizes. Misses' sizes are given by age corresponding to the following bust measures:

18 years—38 bust; 14 years—34 bust
16 years—36 bust; 12 years—32 bust

A foundation form for a child of 12 years is a good size to use if a finished form with a bust measure of 34 inches is desired.

The covering of this form requires 6 yards of some dark-colored cambric which does not soil easily. A lining, closing in the back, is cut from this material, basted and fitted snugly to the person for whom the form is being made. On the carefulness of this fitting depends the success of the fitted form; it must be very snug in order to keep the finished form small enough. Correct curves should be made by darts made in the lining. Sew the waist and skirt together and fit a collar onto the waist. Then take the length and hem the skirt before putting it on the figure.

When all stitching has been done, put the lining on the form and notice where it needs filling out. Two or three rolls of cotton batting will be needed for this purpose and care will be required to get the cotton filled in smoothly. Before sewing up the lining in the back, pin it together and measure it carefully to see that the padding has been done correctly. The form may be tested, too, by trying on a well-fitting waist and skirt.

The cost of this form finished is approximately $3.50 with materials at an average price.

## Alteration of Patterns

Commercial patterns are made to fit average figures and should, therefore, be carefully tested before being used. This may be

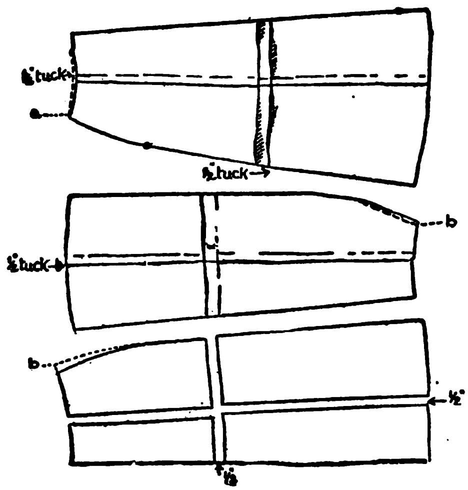



FIG. 185. Altering a skirt pattern

done in 2 ways: (1) Take the measurements of the figure correctly and alter the pattern accordingly. (2) If the garment is to be made of expensive material, first model a garment from cheap material and test its fit as well as its style. In altering patterns, the following measurements should be taken.

**Waist.** A—Neck measure around neck at the base.

B—Length of back from bone at base of neck to waistline.

C—Length of front from hollow of neck to waistline.

D—Width of back, across broadest part of back between armholes.

E—Width of front, across chest 3 inches below hollow of neck.

F—Bust measure around fullest part of bust and straight across the back.

G—Underarm measure from hollow of arm to waistline.

H—Armhole, around the arm over the shoulder bone.

I—Waist measure, snug measure around smallest part of waist.

J—Length of arm, inside of armhole or hollow to wrist and outside from shoulder over bent elbow to wrist.

**Skirt.** Waist (same measurement as I above).

K—Hip measure, taken loosely around the hips 6 inches below the waistline in the front and parallel with the floor.

L—Length; front, side and back are taken from waistline to floor. Any change in length is made from this measurement.

Every woman should own a perfectly fitting foundation waist and skirt pattern. This will serve for a large number of garments since it may be altered and may be used either for a 1-piece or a 2-piece dress.

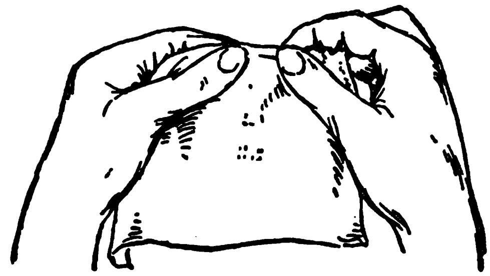


FIG. 186. How to hold goods in making a running stitch

Money may be saved by thus altering patterns already on hand to fit various members of the family. Any alteration in the size of patterns should be made without disturbing the arm's eye, the neck or the curves over the hipline.

## The Construction of Garments

**Cutting.** When the material for the garment has been carefully chosen and the pattern tested according to the measurements of the figure, the next step is the cutting. Be careful to observe closely the following points in cutting material for a garment: (1) Right and wrong side; (2) matching design in figured material; (3) nap; (4) placing pattern on material in economical way; (5) pinning the pattern on securely; (6) cutting with long strokes and using large, sharp shears.

**Stitches.** A—Temporary stitches:

1. *Basting* is the stitch used to hold two pieces of material together until firmly stitched.

(a) Even basting is used when there is a possibility of slipping or a strain on the seam. The stitches are usually made a quarter of an inch long on

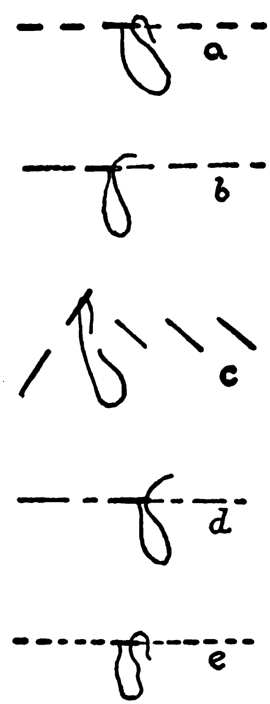



FIG. 187. Types of basting: *a*, even basting; *b*, guide basting; *c*, diagonal basting; *d*, dressmakers' basting; *e*, running stitch.

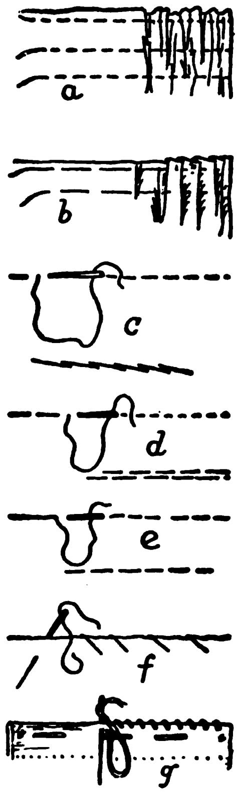



FIG. 188. Types of permanent running stitches: *a* shirring; *b* gauging; *c* backstitch, right and wrong sides; *d* stitching stitch, right and wrong sides; *e* combination stitch, right and wrong sides; *f* overcasting; *g* overhanding.

both the upper and under sides of the material.

(b) Uneven (guide) basting is used where there is little or no strain, or to mark lines for joining materials. The space between the stitches is longer than the stitch itself (three eighths inch and one eighth inch respectively).

(c) Diagonal basting is used where more than one row of basting is needed, as it may be substituted for two rows of basting. The stitch varies in length from a half inch to 2 inches, according to the purpose for which it is used.

2. *Tailor's tack or mark stitch* has as its purpose: (1) the marking of seams in tailored garments so that both sides of the garment being made will be exactly alike; or (2) to mark plaits, etc., in commercial patterns in order that the various parts may be more easily matched.

Mark stitches are made by using a double thread of basting and a double thickness of cloth. Take 2 even basting stitches, then skip one half to three quarters of an inch and take 2 more stitches, leaving a loop of thread 1 inch to 1½ inches long between each two. Then separate the 2 pieces of material and cut the threads between them. In this way both pieces of the garment are marked exactly alike.

B—Permanent stitches:

1. *Running stitch* is used for gathering or tucking, and for seams that do not require strength. These stitches are made like even basting, but much shorter. Several stitches should be taken up before pulling the needle through the material.

2. *Back stitching* is used for seams where there is much strength required. To make this stitch, first take a very short stitch, then put the needle back to where it was first put into the material and bring it out the same distance beyond. Take the second stitch by putting the needle back to the end of the last stitch and bringing it out the same distance beyond. Always advance from the under side of the material, making the under stitch twice the length of the top stitch. When carefully done, back stitching closely resembles machine stitching.

3. The *combination stitch* is a combination of the running and back stitches, made by using 3 running stitches, then a back stitch, then 3 running stitches, then a back stitch and so on, until the seam is completed. This stitch is used where more strength is needed than may be given by the running stitch.

4. *Overhanding* is used in holding together two edges, usually selvages. This stitch insures a flat seam. After basting the edges together, hold the material in the left hand with the edges between the thumb and forefinger. Take the stitches very close together just deep enough to catch the material with the thread, going over the edges of the material with the needle pointed directly toward the worker. When completed the seam may be opened and pressed perfectly flat, the selvages just touching.

5. *Overcasting* is made over and over the edge of material to keep the raw edge of a seam from raveling. This stitch may be made quite rapidly when several stitches are taken at one time.

6. The *blanket stitch* is used to finish the edges of flannels and other woolens. The edge of the material is held next to the seamstress and the stitch is made by bringing the point of the needle out over the thread, then drawing the thread up to form the stitch.

Seams.

*A* — The *French seam* is used in making undergarments and outer garments modeled from light-weight materials. To make this seam, allow three eighths of an inch in materials which do not ravel and three quarters of an inch in materials which ravel.

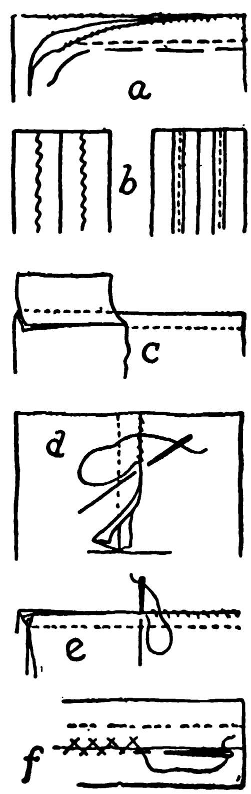



FIG. 189. Types of seams: *a* plain seam; *b* pinked seam (*left*) and bound seam (*right*); *c* French seam; *d* hemmed fell; *e* overhanded, or French fell; *f* flannel fell.

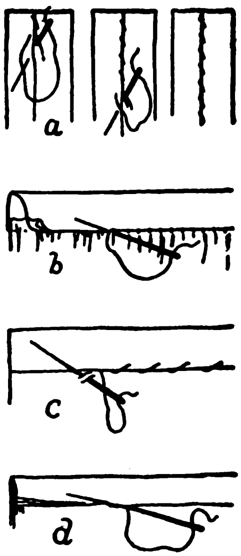



Fig. 190. Types of plain hemstitching: *a* plain hemming; *b* vertical hemming; *c* blind hemming; *d* slip stitching.

Pin and baste together the materials and make the first stitching on the right side of the material one eighth to one quarter inch from the edge. Then reverse the fold so that the seam edges come within the fold, crease, and stitch one fourth inch from the edge. This row of stitching must entirely cover all raw edges from the first stitching. This seam may be used in hand-made garments, the running stitch being used for the first stitching, and the combination or back stitch for the second.

*B*—The *hemmed fell* is used in making undergarments. To make it, place the two right sides of the cloth together. Baste and stitch so that the upper side of the stitch comes to the right side of the seam. Trim the under side of the seam to one quarter or one eighth inch. Fold the wide edge over the narrow and baste both flat to the cloth. Then hem the edge of the fold to the cloth.

*C*—The *stitched fell* is made like the hemmed fell except that all stitching is done by machine and the seam is finished on the right side of the garment instead of the wrong.

**Hemming.** A hem serves the purpose of a finish for a garment or that of an ornament.

*A*—*Plain hemming* is made by twice folding the edge to be hemmed, the first fold very narrow (one eighth inch), the second the width of the desired hem. The second fold is first basted securely into place and then fastened down with a slanting stitch taken through both thicknesses of material. This stitch is commonly called a whipping or hemming stitch. The edge of the material is held away from the worker, the material itself in the left hand, and the needle in the right, always working from right to left. When working with silks or materials where close stitching is not desired, the stitch may be made as described above, but the distance between the stitches increased. This is called the slip stitch.

*B*—The *napery or French hem,* is used on table linens, etc. To make it, crease the material as for the plain hem, then turn the second fold back on the material. The stitch is the same as given for the overhand stitch.

*C*—The *rolled hem* is used on sheer materials when setting in insertion or applying lace. This hem is made by trimming the edge of the material evenly, then with the wrong side toward the worker, rolling the edge tightly with the thumb and index finger of the left hand. The needle is started toward the left, the stitch going under and over the roll, thus keeping the raw edge from showing.

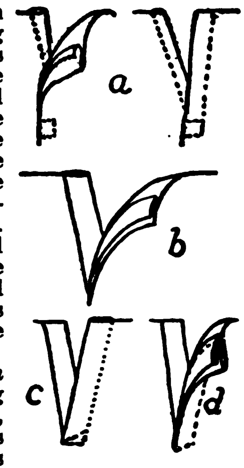



Fig. 191. Types of placket: *a* two methods of making hemmed placket; *b* bound placket; *c* bound and faced placket; *d* continuous bound and faced placket with fly.

*D*—The *flannel hem* is used in the making of infants' garments, etc. The raw edge is not turned in, but is held in place with a catch stitch on the wrong side. The right side may be finished with some simple decorative stitch.

*E*—The *shaped hem* is used in the finishing of undergarments. To make it, turn the material up on the right side after the desired length has been taken. Then mark off the scallops the desired shape and size, stitch and cut around the scallops ¼ inch below the seam. Turn the hem so that the scallops will be right side out. Baste securely and stitch on both the edge of the scallops and at the top of the hem. If desired a simple decorative stitch may be used at the top of the hem.

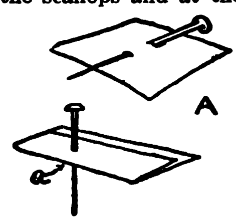



Fig. 192. Methods of marking position of buttonholes.

**Plackets.** The *hemmed placket* is used in garments where there is little strain and is the simplest in construction. The slit is cut, and hems folded on either side, the one which is to make the lap being made wider than the one underneath. A plait is thus formed below the vent. A double row of stitching should be made across the bottom of these hems to strengthen the placket.

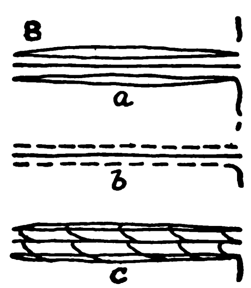



Fig. 193. Methods of stranding buttonholes (*a*) and (*b*); *c* overcasting buttonhole.

The *bound and faced placket* is used for both undergar-

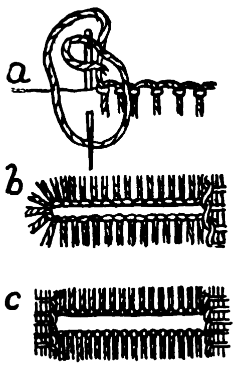



FIG. 194. Types of buttonhole stitches: *a* buttonhole stitch; *b* buttonhole with fan and bar; *c* double-bar buttonhole.

ments and outer garments. To make this placket, cut a lengthwise strip of material twice the length of the placket and twice the desired width of the facing plus the seam (1½ to 2 inches). Place the right side of the facing to right side of garment, and baste with narrow seam around the entire opening. Stitch by machine, holding garment on top to avoid stitching in folds of material. Crease the strip of material into place, as a bound placket would be. On the back of the placket cut the facing away one eighth to one quarter inch beyond the center crease. Turn in one eighth to one fourth inch on edge and baste facing down to garment. Hem or stitch the facing and stitch diagonally across the lower end to make firm.

*Shirtwaist sleeve placket.* Cut the opening as long as desired—usually 4 inches long and 1 inch from the fold on the under side of the seam. On the underneath edge sew a narrow strip with a seam on the right side, turn the edge under as for facing and stitch back on right side of sleeve. The overlapping part is longer than the placket and wider than the underfacing. This part, like the under part, is sewed with a seam on the right side, turned and stitched down on right. This part may be shaped or not at the upper end.

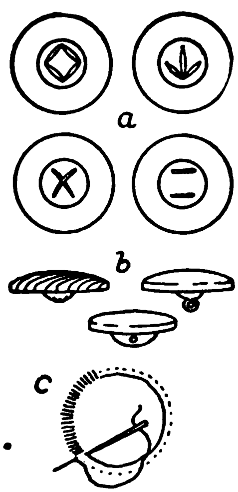



FIG. 195. *a* Methods of sewing on a four-holed button; *b* shank buttons *left*, cloth shank, *right*, metal shank, *bottom*, bone shank; *c* eyelet for shank button.

### Methods of Fastening Garments

**Buttonholes** should always be made on double material on the right side of the garment. Use thread not too coarse but suitable for the weight of the material and long enough to complete all steps in the work, which are as follows:

1. *Cutting.* First select the size of the button to be used and cut the hole accordingly. Buttonhole scissors are very convenient for cutting the holes. If these are not at hand cut the hole thus: Fold the material, and mark with a pin from the fold of the material half the width of the button. Then cut the folded material to the pinhole, the cut being made along the threads of the material.

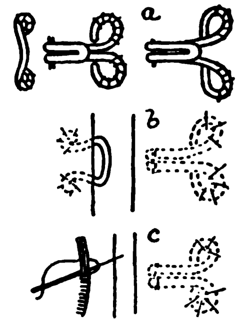



FIG. 196. Methods of sewing on hooks and eyes: *a* hook and straight eye; *b* hook and round eye; *c* sewing on hook and making thread loop.

2. *Stranding* is the second step in the making of the buttonhole. It is a succession of running stitches placed along the sides and is used to add strength and also shape. The stitches may be as long as the size of the hole requires.

3. *Overcasting* is used in making buttonholes in material which ravels. This stitch is made just like the overcasting for raw seams, being careful to take the stitches as shallow as possible and not to draw the thread.

4. *The buttonhole stitch* is made by inserting the needle just beyond the stranding threads, bringing it to the right side of the garment. When the needle is half through the material, pass the thread from the eye around and under the point of the needle from right to left. Draw the needle through and away from the worker so the purl of the stitch may be along the cut edge. Keep the stitches as nearly the same depth as possible.

There are two finishes which may be used for the ends of the buttonhole: (a) the fan and (b) the bar. The *fan* is made in the end of the buttonhole where the button will rest by continuing the buttonhole stitches in a circular shape around the end of the hole. The *bar* is usually used in the opposite end from the fan to prevent the tearing of the buttonhole. This is made by taking 2 or 3 running stitches across the end to be barred, and then applying the blanket stitch.

**Buttons.** When the buttonhole is made, find the place to sew on the button by lapping the end of the band or plait as desired and sticking a pin at the outside end of the buttonhole. Remove the pin and fasten a double thread at this place with several small stitches. Put the needle through one of the holes, place a pin on top of the button and sew back and forth across the pin. Remove the pin, then wind the end of the thread around the loose threads between the button and the cloth to make a stem. This protects the button from pulling off in the wash and prevents its tearing the cloth.

**Hooks and eyes.** Place the hook on the

right side of the opening, the eye on the left, each far enough back so they will not show when the garment is fastened. Sew neatly around the circular ends of both and tack across the hook shanks to keep them in place. The blanket stitch may be used at the circular ends, but the added neatness and strength scarcely pay for the extra time expended.

Snap fasteners are sewed neatly and securely with several over and over stitches.

Eyelets are made by punching a hole in the material with a stiletto or other round, pointed tool, and strengthening the edges by either (a) overhanding closely, (*b*) using the buttonhole stitch with purl on outer edge; or (c) with the purl on the inner edge.

Loops are made by tacking 3 or 4 stitches back and forth the length desired for the finished loop. The ends are fastened securely and the threads completely covered with the blanket stitch. These stitches should be very close together to strengthen the loop.

**Stitches used in mending.** Every woman should practise economy by mending and darning worn garments of the family wardrobe, thus lengthening their life and improving their appearance. It should be a matter of pride with every girl that her wardrobe is kept in absolute repair.

Holes may be repaired by either patching or darning. Patching is reinforcing holes or worn places with cloth; darning is reinforcing them with threads. Whether a patch or darn is used depends upon (a) size of hole, (b) garment to be mended, (c) material of garment.

There are 2 types of patches—the hemmed and the overhand patch.

The *hemmed patch* is used principally with wash materials. To make it crease the material along the thread or figure, equally distant from the center of the worn place, forming a perfect square or rectangle. Place pins at the four corners, and cut the material diagonally to the pins, turning the edges to the wrong side. Baste these edges in place. Place the material which will form the patch underneath the hole, matching the warp and woof and the design (if figured), and baste carefully. On the right side sew the patch to the garment with small hemming stitches. On the wrong side, cut away the extra material from the garment, trim the patch evenly all around and hem the patch into place.

The *overhand patch* is used a great deal on woolen and silk materials where there is little strain. As in the hemmed patch, cut away the worn part and turn and baste the edges. The cloth for the patch is then carefully matched in pattern and threads, and creased to fit the hole exactly. Then it is folded back on the material of the garment, basted, and the overhand stitch applied in order that the straight stitch may be imbedded in the threads of the material. To prevent raveling, the raw edges on the wrong side are finished with the overcast stitch.

*Darning* is used for mending tears and worn places, as well as holes. In mending tears, one must consider the position of the tear in regard to the warp and woof. If the material is woolen or silk, the mending thread should be, if possible, of the same. The running stitches which are used should always follow the weave of the material.

Stocking darning should be done with thread as nearly as possible the weight of the stocking itself. The frayed portion of the hole, which will cause unnecessary thickness, should be cut away. Running stitches are used in this mending, the work always being done on the wrong side. The use of a darning ball facilitates the work.

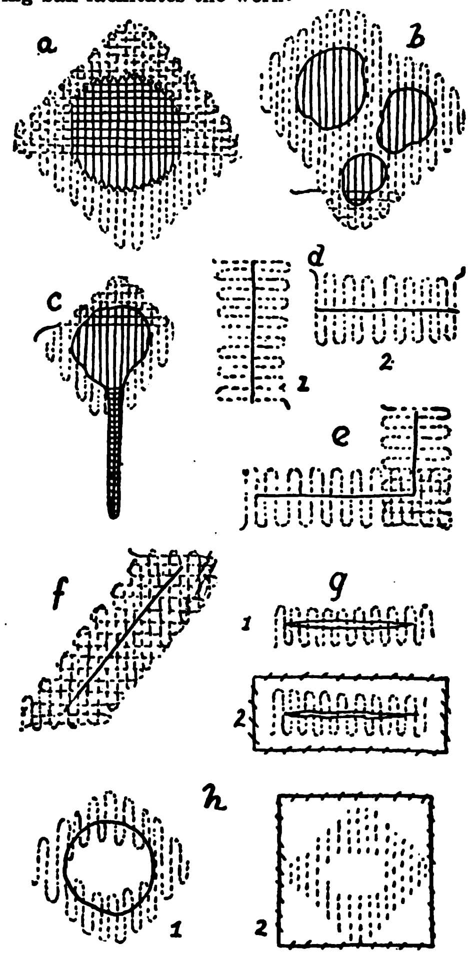



FIG. 197. Types of darns in knitted materials: (*a*) stockinet darn; (*b*) darning several holes together; (*c*) darning a hole and a run; (*d*1) darning a warp tear; (*d*2) darning a woof tear; (*e*) darning a hedge, or corner, tear; (*f*) darning a diagonal tear; (*g*) reinforced darned tear: (1) right side, (2) wrong side; (*h*) reinforced darned hole: (1) right side, (2) wrong side.

## Fancy Sewing

(*By* Mrs. H. J. Keyes)

In the farmhouse, where toil is constant and hard, and where the laborers need the most refreshing rest, beauty has a special service to perform. How much easier to work in, how much lovelier to rest in, is the home which has been adorned with the handiwork of its women! The embroidered cover, or doily, or curtain makes the house into a home, just as words and acts of affection do. It is like a caress, softening the harder lines of utility and duty.

The more we know about anything, the more interesting it becomes to us; so, the more we know about embroidery, the more deeply do we enjoy doing it. Although the simplest of work upon the cheapest of materials is worth while if it gives pleasure to the worker and to the members of the home where it is used, still needlework may become far more fascinating and beautiful if we can take time to study, even if a little. (1) The laws of good design; (2) the use of color and shadings; and (3) the effects produced by different stitches, the materials on which they look well, and the threads with which they are best worked.

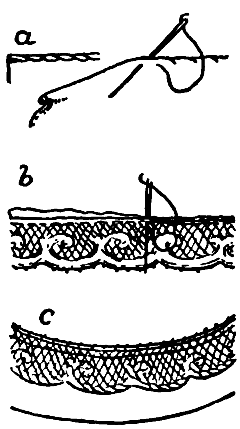



Fig. 198. Decorative lace work: *a* rolling and whipping; *b* whipping over raw edges; *c* appliquéing lace, wrong side.

**Design.** You can not make a good picture with embroidery. The best patterns, therefore, are those which do not try to copy exactly, so that they look real, the flowers, birds, bees, etc., which are to be worked. The pattern should merely suggest these, reducing the drawing of them to the boldest, most important lines, and keeping them flat-looking instead of rounded like the objects themselves. This is the difference between pictures and decoration. Embroidery is done for the sake of decorating useful objects with graceful lines and pleasing colors, not for the sake of making pictures. Roses on the bureau covers should not look as if they ought to be picked up and put in water, nor should bees on the centerpiece look as if they would sting.

**Colors.** Because embroidery is decorative, not pictorial, we need not imitate the color of the object suggested in the color of the thread. Nothing is handsomer than heavy blue or soft green embroidery on table damask, and white on white has special charm. In using silk thread, the delicate shades are better than the heavy ones so effective in linens and mercerized cotton. Whatever thread one is using, 3 or 4 shades may be combined, and the effect is far stronger when these are not too delicately blended, but are blocked in boldly like the strong patches of light and shadow made by sunlight.

**Materials and operations.** A square frame to which the work is laced is better than the common hoops, which stretch the material into forms like themselves and injure the stitches which may have to be confined between the 2 hoops. If the square frame is on a stand it leaves both hands free for sewing. An old thimble worn smooth is excellent, especially in working with silk. Needles should have large eyes so that the thread will not be roughed up in passing through them.

To trace a pattern, draw it on butter paper, then, with an unthreaded needle on the machine, prick the outlines. Baste this on your cloth and sew through it, tearing it off when finished.

To copy a piece of embroidery already finished, lay your cloth on a padded ironing board, dampen the embroidery and baste it, design down, on a piece of cloth laid over your material. Lay a thin cloth over all and then press them till dry. Your new cloth

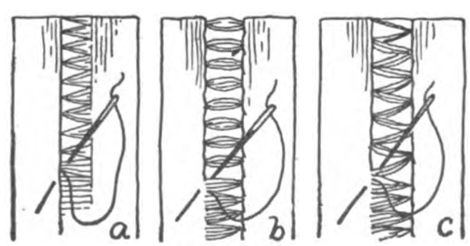



Fig. 199. Various types of hemstitching: *a* hemstitching; *b* double hemstitching; *c* diagonal hemstitching.

will show the pattern, which you can outline with a pencil.

Stitches. There are several families of stitches, the members of which resemble each other and are capable of doing certain things and incapable of doing others, a good deal like the members of human families. Just as a household of musicians if asked to cultivate a farm would probably raise poor crops, so the various canvas stitches, for instance, if placed on silk or muslin would be unsuccessful, whereas they are very decorative on materials of coarse, open weave.

The embroiderer ought to learn these families of stitches and experiment with them till she knows to what materials and threads they are suitable and with what other stitches they will combine handsomely. Then, before beginning a piece of work, she can plan it out definitely, which is far safer than to change stitches haphazard as she goes along. Simplicity is a wise rule, however, and the use of few stitches is better than a confusion of many. As there should never be more than one kind of thread in one piece of embroidery, the combination of stitches is limited to those which look well in a certain thread.

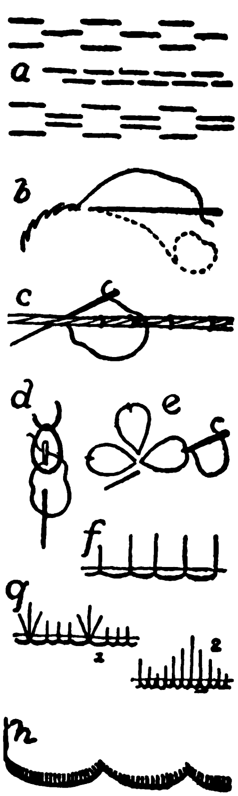


FIG. 200. Embroidery stitches: *a* decorative running stitch; *b* outline stitch; *c* couching; *d* chain stitch; *e* lazy daisy; *f* blanket stitch; *g* variations of blanket stitch; *h* scalloping stitch.

Embroidery stitches may be described as follows:

The *cross stitch* may be made over the threads in loosely woven materials such as scrim or canvas. In fine materials, canvas must be basted into place, the stitches made over this and the canvas removed; or if a pattern is stamped upon the material, no canvas is needed. The stitch is made by taking the needle from the lower left-hand corner of the square to the upper right-hand corner, making a slanting stitch. Then a stitch is taken on the underneath over to the upper left-hand corner, brought through the material to the lower right-hand corner, making a second slanting stitch which crosses on top of the first and completes one cross stitch. The needle is again brought up at the lower left-hand corner of the next square, and so on.

The *chain stitch* is used for outlining, or for filling in spreading patterns over large surfaces. It is done with twisted silk on heavy goods; or with flat-silk floss, linen, or mercerized cotton on flimsy materials. In making this stitch, a succession of blanket stitches are made one after the other. *The lazy daisy* is a variation of the chain stitch. Two stitches only are needed for each petal of the daisy. The first is a chain stitch, the second is taken through the material to hold the first in place.

The *outline stitch* is made on a line from left to right, the stitch being longer on the right side than on the wrong side. The thread must be thrown on the same side each time in order that the effect will be regular.

The *feather stitch* is used for border work, outlines, or for filling in geometrical patterns. It is very effective as trimming for clothes. The thread should match the material as nearly as possible. It is made with a slanting stitch toward the center, first on the right and then on the left side. The brier stitches are made more parallel but are made alternately on the right and left.

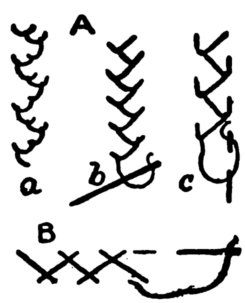


FIG. 201. A, Types of featherstitch: *a* double; *b* single; *c* coral. B, cross-stitch.

The *French knot* is made by bringing the needle through the material where the knot is desired, the thread thrown over and under the left thumb, or over the needle, making a loop, the loop pulled down to the material and a small back stitch taken, bringing the needle out where the next knot is to be. French knots are very attractive used either alone or in combination with other stitches.

The *satin stitch* is used on materials of all kinds, but particularly fine ones, including silks. It is done with flat cotton or linen threads or silk floss—never with tightly twisted threads. It is most beautiful for flower designs, giving brightness and luster to the surface. The satin stitch usually has as its foundation the chain or outline. If the material is especially sheer, each stitch is the width of a thread apart. The padding is always made at right angles to the direction in which the satin stitches are to be made.

*Darning* is a succession of parallel rows of short regular stitches, done with any loose, flat thread. It combines well with the outline or satin stitches, and fills in a background handsomely, in which case the

pattern may be produced by darning around it.

*Couching* permits the effective combination of two colors, since two threads are used in making the stitch. One is held in place on the material; the other is used to fix it there, the stitches, one quarter to one half inch long, being made over the first thread, at right angles to it and on the wrong side.

The *blanket stitch*—an edge finish—begins with several small running stitches at right angles to the edge of the goods, the needle being brought out as near the edge as possible. Proceeding from left to right, for the first stitch the needle is inserted one eighth to one half inch from the edge according to the material. The thread is thrown under the point of the needle from left to right and the needle drawn through toward the worker. Succeeding stitches are taken the same way, equal distances apart and the same distance from the edge.

## Hints on Laundering and Removing Stains

(*By* Mary Elizabeth Robinson)

One of the hardest tasks confronting housewives is the weekly washing; yet if the principles of the work are studied and if the house is equipped with labor-saving devices, it need not prove burdensome. The time will come, let us hope, when every farmhouse will have a laundry room fitted with stationary tubs, faucets, drain pipes, a washing machine operated by motor or engine and, of course, running hot and cold water. Meanwhile, wise women will learn to know the different fabrics to be laundered, just as they study them in relation to sewing practices. (See p. 213.) Some of the more important points are the following:

**Wool** fibers vary in length from 1 to 11 inches, and under a microscope are seen to be composed of small segments called cells, with hook-like, overlapping edges forming a characteristic horny layer. When woolen materials are wet, the fibers expand and the projecting edges loosen. As the fabric dries, the little hooks interlock, drawing the fibres close together so that we say the garment "shrinks." With careful washing and rinsing in waters of the same temperature (which should not be more than comfortably warm to the hand) this shrinkage is slight. It is increased by the use of very hot water, or by a change from hot suds to cold rinse water. Much rubbing or ironing with a hot iron will also increase shrinkage, as will the use of strong soaps or other alkalies. Mild soaps or weak solutions of borax are less harmful.

**Silk,** spun as one long, continuous thread by the silk worm, is lustrous, elastic and the most delicate of all fibers. Like wool, it is completely destroyed by strong alkalies and injured by hot water, strong soap, hard rubbing, and ironing with hot irons. A hot iron yellows silk and causes the fiber to stiffen and sometimes break.

**Cotton** fibers are twisted, ribbon-like, tubes varying from three fourths of an inch to 1½ inches in length, according to variety. The slight twist gives them their valuable spinning qualities.

**Linen,** a fiber from the inner part of the flax stem, is identical in composition with cotton. Alkalies have very slight effect on either, though if strong soaps are continuously used, the garments may be yellowed and the fibres gradually weakened.

### The Laundry Equipment

**Water.** This should be clean, soft, clear, odorless and free from discoloration, iron and organic matter. Some water is hard (and, as every woman knows, undesirable for washing purposes) because it contains mineral matter which it dissolves and takes up as it flows along through the earth underground. These minerals combine with soap to form a scum, and the soap will not lather or cleanse till enough has been put into the water to unite with all the mineral present. Hard water, then, is not only inconvenient but also wasteful.

**To soften hard water.** If the mineral contained is only carbonate of lime, the water may be softened by boiling it and letting it stand till the lime settles to the bottom. Other minerals usually found in water, and which make it "permanently hard" are not affected by boiling. Probably the best alkali to keep on hand for softening such water is a solution of washing soda (sodium carbonate, or sal soda) made by dissolving 1 pound of it in 1 quart of boiling water. Allow 2 tablespoons of this solution and 1 tablespoon of borax dissolved in 1 cup of water, to every gallon of wash water. Washing powders and preparations for softening water are on the market, but they usually are more expensive and may be so strong as to injure the garment fibers. If a washing powder is used it should always be dissolved in a little water and this added to the tub of water and well stirred through before the clothes are put in.

**Soaps** are compounds made by the action of strong alkalies on fats. Their cleansing


Fig. 202. A glass rod is useful in removing stains. Use a pad of cloth or paper beneath the goods

power is due to the fact that as soap decomposes when brought into contact with water the alkali thus set free dissolves or "cuts" the grease and other dirt, while the fatty acid part of the soap entangles the impurities and carries them off in the waste water. Cheap soap is no economy for it usually contains strong alkalies that in time wear out the clothes.

A soap solution makes suds more quickly than cake soap, cleans more evenly and wears the material less. Dissolve 1 cake of white soap or 2 cups of soap flakes, chips or scraps in 3 quarts of hot water. For blankets, add 2 tablespoons of borax and ½ cup of ammonia.

Bluing is unnecessary if garments are washed properly, well rinsed and then bleached in the sunshine, but if used the better grades are the most economical. There are various kinds of bluing, as follows:

a. *Indigo*, now very little used and never sold as commercial blue.
b. *Prussian blue*, a good color and easy to use. However, it is an iron compound and unless the clothes are thoroughly rinsed the soap left on them will break down the blue and the iron part will form tiny spots of rust on the goods.
c. *Ultramarines*. These are usually put up in balls or squares. This blue does not dissolve, but mixes with the water, finally settling on the sides of tub, or on the clothes. The blued water should, therefore, be well stirred before the clothes are put in.
d. *Aniline blue*. One of the best forms but as it is a coal tar product and a dye it must be used with great care because it cannot be removed if too much is used. It must be used in connection with an acid.

**Starch.** In starching clothes much trouble may be avoided by cooking the starch thoroughly first. Borax, alum, paraffin and gum arabic are sometimes mixed with the starch to prevent the iron from sticking; they also improve the color of and give pliability to the cloth. Rice starch is superior to corn starch for lawns, fine muslins and laces.

A complete modern laundering equipment will include the following, although some of the items may be dispensed with or borrowed from the kitchen equipment when needed: a washing machine, run either by hand, electricity or a gasoline engine; fibre tubs or, better, one or more stationary tubs with drains, of either porcelain, enameled ware or alberine stone; wringer; laundry bench; boiler (copper-bottomed); ironing machine or irons, either electric, gas, Mrs. Potts, or sad (8 pounds); ironing board; ironing blanket; sleeve board; miscellaneous supplies, such as rubbingboard (metal or glass), wooden spoon, iron holder, iron stand; clothes basket; pail (enamel or fiber) for emptying water and carrying clothes; dipper; dishpan, enamel); measuring cup; clothes stick; scrubbing brushes; strainer for starch; beeswax or paraffin wrapped in cloth to keep iron smooth; case knife; clothes horse; clothes, aprons (best made of ticking); two enamel sauce pans (one for starch and one for soap solution); teaspoon; tablespoon; clothespins; clothes line. The latter, if of wire, should be non-rusting and kept free of loose or broken strands; if of rope, it should be taken down when not in use and occasionally washed.

## How to Remove Stains

Most dirt in clothing is removed by ordinary washing, but certain stains require special treatment. Some are insoluble in water, or may be permanently set by the action of heat during the washing. Clothing should be looked over and such stains removed before the washing begins. Fix in your mind the following general rules about removing stains:

a. Treat any stain as promptly as possible.
b. Try simple methods first.
c. Consider the nature of both the material and the stain. All materials are not treated in the same way.
d. Experiment on a sample if you are uncertain as to the effect of a chemical.
e. Keep all stain removers properly labeled, in one special, handy place. These should include:

*Fuller's earth* or *French chalk*

*Turpentine* (inflammable)

*Benzine, naphtha*, or *gasoline* (inflammable)

*Carbon tetrachloride* (non inflammable). Sometimes purchased under name of Carbona.

*Alcohol* (inflammable)

*Oxalic acid* (a poison). Dissolve 1 ounce of crystals in ¾ cup of hot water.

*Potassium permanganate*. Dissolve 1 teaspoonful of crystals in 1 pint of water.

*Javelle water*. Dissolve ½ pound of chloride of lime in 2 quarts of cold water; dissolve 1 pound of washing soda in 1 quart boiling water; pour the clear liquid from the chloride of lime into


FIG. 203. Sometimes the chemicals may be dropped upon the goods stretched over a bowl of clean water

the soda solution, let the mixture settle, strain through a cloth into bottles, cork and keep in a dark place.

*Hydrogen peroxide.* A few drops of ammonia added just before it is used, makes it work more quickly.

*Ammonia.*

*Borax.*

The more common stains encountered in farm laundry work and methods of removing them are as follows:

**Blood.** 1. Wash in cold water until stain turns brown, then apply soap and soak in warm water. 2. Starch paste may be used on thick goods. Renew until stains disappear.

**Bluing.** Use boiling water.

**Chocolate or cocoa.** Sprinkle with borax and soap in cold water.

**Coffee and tea** (clear). Pour boiling water through the stained part. Bleach if necessary. (With cream). Wash in cold water; pour soap and cold water through.

**Egg.** Wash in cold water.

**Fruit and fruit juices.** 1. Treat with boiling water poured from a foot or two above. 2. If stain persists, soak for a few minutes in a solution made from equal parts of javelle water and boiling water. 3. Rinse thoroughly with boiling water to which a little diluted ammonia water has been added.

**Grass.** Use cold water, mild soap and water, alcohol or a bleaching agent.

**Grease and oils.** 1. French chalk, Fuller's earth or blotting paper. 2. Warm water and soap. 3. Gasoline, benzine, or carbon tetrachloride.

**Iodine.** Use warm water and soap, alcohol, or ammonia. If in starched goods, a weak solution of sodium thiosulphate (the photographer's "hypo") is suggested. Dip stain in this, then rinse.

**Ink.** 1. If fresh, soak stain in milk; repeat as milk becomes discolored. 2. If old, use javelle water applied with medicine dropper and follow with dilute ammonia water. 3. Or apply potassium permanganate with dropper and then oxalic acid.

**Iron rust.** Use oxalic acid or lemon juice and salt.

**Kerosene.** Use warm water and soap.

**Lampblack and soot.** Use benzine, gasoline or carbon tetrachloride.

**Medicine.** Use alcohol.

**Mildew.** 1. If fresh, use cold water. 2. If old, bleach with javelle water or potassium permanganate.

**Paint and varnish.** 1. If fresh, use alcohol, turpentine or carbon tetrachloride. 2. If old, use equal parts of ammonia and turpentine.

**Perspiration.** 1. Wash in soap and warm water and bleach in sun. 2. Oxalic acid.

**Scorch.** 1. Bleach in sun. 2. Bleach with javelle water.

**Shoe polish.** (**Black**). Use soap and water or turpentine. (**Tan**). Use alcohol.

**Stove polish.** 1. Use cold water and soap. 2. Treat with benzine or gasoline.

**Vaseline.** Use kerosene or turpentine.

## How To Renovate Materials

**Woolens.** Clean with gasoline, benzine, chloroform, carbon tetrachloride or tepid water and mild white soap applied in solution. Rinse thoroughly. "Shiny" parts may be made less noticeable by sponging with hot vinegar, and pressing with a piece of canvas placed over the material. This freshens the material and raises the nap of the cloth.

**Silks.** Dampen evenly with slightly warm water (1 pint) and alcohol (1 teaspoonful). Press carefully between papers. Mild, white soap may be added to water if a stiffer silk is desired.

**Pongee.** Wash in lukewarm suds, rinse and hang out until dry. Iron without sprinkling or dampening.

**Velvet.** Brush clean with gasoline, air thoroughly, dampen evenly on wrong side and steam over a medium hot iron. This freshens the velvet and raises the pile.

**Cotten velveteen.** Wash in suds made from mild white soap. Rinse in several waters. Do not wring but hang out dripping wet. Iron on wrong side when half dry.

**Millinery Materials**—Flowers (retinting). For cotton use water colors. For silk or velvet use oil paint and gasoline.

Feathers (ostrich). To recurl, use dull knife or steam. To retint, use oil paint and gasoline.

Straw hats and Panamas. 1. Wash with warm water and mild, white soap applied with stiff brush. 2. Rinse. 3. Bleach with peroxide of hydrogen, sulphur applied in form of paste, or lemon juice and salt.

Leghorns. Wash with warm water and white soap.

Milans and Chips. (*White*) Clean with art gum; if sunburned, bleach with peroxide of hydrogen. (*Black*) Brighten with ammonia; retouch with shoe polish. Any light-colored shade may be retinted with hat dyes, or blackened with shoe polish.

# HOUSEHOLD PESTS

(*By* MRS. HELEN JAHNSAN KEYES)

**THE CLOTHES MOTH.** This is one of the most expensive of our household enemies, but one of the easiest to defend ourselves against. There are two kinds of destructive clothes moths, the case-making one of our northern states, which lays its eggs only once a year, in the spring; and the webbing moth of the South, which breeds in May and again in August and September. The northern housewife, therefore, has to fight against moths only once a year, when it is about time to lay away winter clothing. In southern localities the fight against them is almost continuous.

Only the larvae of the moth, the dull white caterpillars, destroy our clothing. The adult insect is harmless except as a layer of eggs.

First, the adult moth seeks a quiet, dark place to lay her eggs. She likes a greasy spot on some substance which the larvae will eat. Moth larvae will eat only animal food, such as wool, silk, furs, and feathers. They will have nothing to do with vegetable fabrics, such as cotton and linen. So the mother seeks our most expensive clothing and furnishings for the cradle and food of the creatures which are to hatch from her eggs. Not only this, but the larvae themselves have the power of crawling about and finding their own food if they are not cradled in it. When moths lay their eggs in cracks and crevices of floors, closets, trunks, and other storage places, the larvae creep out and hunt for what they want to eat.

Our war against moths, therefore, is of two kinds: (1) Prevention, or so caring for our things that no eggs will be laid in them. (2) Destruction of the eggs or larvae, which must be resorted to if prevention has not been successful.

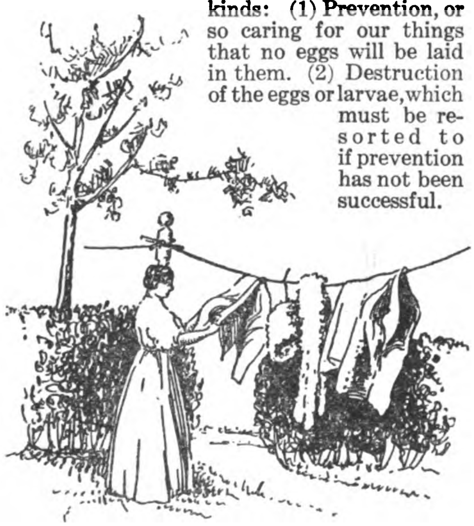


FIG. 204. Frequent airing and thorough brushing are the best preventives of moths

**Prevention.** In the early spring, fabrics made from animal substances should be taken into the direct sunlight and thoroughly brushed, and in case of furs, even combed, to cleanse them of any moth eggs which may have been deposited in them. They can then safely be put into sealed packages, bags, or boxes and kept there till autumn without the addition of those pungent odors—camphor, naphthaline, moth balls, tobacco and pepper—which are commonly used. Because adult moths have no power to bite, they may be kept off by paper, cloth or wood if all the cracks in these materials are sealed. Paper packages thoroughly sealed are entirely secure, but as paper tears readily, it is safer to put such bundles into boxes and to close the cracks of the boxes with strips of paper fastened down with flour paste or other adhesive material. The easiest way, however, is to make a number of unbleached cotton bags, lay the cleansed garments in them, tie them up tightly, mark them with what they contain, and lay them on shelves or in drawers, or hang them in closets.

The method that we have spoken of does not require any disagreeable odors. The odors which are commonly used do not kill eggs or larvae, they merely keep away the moth that is seeking a spot to lay her eggs. They do just what a sealed package or tightly closed bag does—they keep her out.

**Destruction.** Gasoline, benzine, and naphtha destroy eggs and larvae, and may be applied to furs, feathers, woolen, and even silk fabrics without injuring them. The things must be dried thoroughly, however, before being packed away or brought near a flame. The fact that petroleum products easily explode or catch fire, must be kept in mind or terrible accidents may result.

To avoid these dangers, the following recipe which has the advantage over many other moth poisons in being harmless to children and household pets, may be used in the cleansing of cracks and crevices: Alum, 4 ounces in 1 pint of water; salt, 4 ounces; spirits of turpentine, half a pint.

It is well to repeat these treatments frequently during the spring and summer seasons.

**THE CARPET BEETLE OR BUFFALO MOTH.** This beetle, like the clothes moth, destroys woolens when in the larvae state, and has a particular affection for carpets, which it eats in slanting lines. As an adult, it is black and white with a red stripe down its back, and is less than a quarter of an inch long. This is about its size, too, as a caterpillar.

**Prevention is best accomplished by doing**

away with carpets, and using movable rugs on finished floors.

Carpets must be taken up, soaked in benzine and hung in the direct sunlight all day. All floor-cracks and baseboards must be washed in an alum, salt, and turpentine mixture. A heavy tar paper should be spread over the floors before the carpets are laid again, if it is necessary that they should still be used. Several such cleanings will probably be required before the creatures are destroyed. One cleaning in the middle of the summer is particularly effective.

**BEDBUGS.** Bedbugs are small, reddish, flat insects, with an offensive odor. They infest not only beds but walls, creeping out after dark and making their meals upon sleeping people. They are known to carry the germs of certain diseases, particularly those of typhus fever.

Cleanliness is the best preventive. Bedsteads should be kept free from dust and frequently washed with a cloth wet in kerosene. Particular care must be given to joints and cracks, into which boiling water and kerosene ought to be poured as an occasional preventive. The places under the tufting and along the binding of mattresses need to be kept dustless and constantly examined with suspicion. In repapering rooms, a new paper should never be laid over the old one, but the walls should be scraped and then washed down with 2 pounds of alum in 3 quarts of boiling water.

There are several excellent bedbug exterminators on the market. An equal mixture of kerosene and turpentine is also good, and there are various recipes for the combination of corrosive sublimate with alcohol, camphor and turpentine. Corrosive sublimate, however, is such a deadly poison that it is best to avoid its use. Whatever mixture is selected, it should be forced into the cracks of furniture and woodwork and under the tufting and binding of mattresses with a spray apparatus, which costs but little. A thick coating of hard oil varnish, laid with a soft, small brush upon bedsteads, springs, and woodwork, is an excellent exterminator. In the case of metal bedsteads, a drenching with kerosene, which is then set on fire and allowed to burn out, is a new and effective method, but, of course, it requires great care.

FIG. 205. In destroying buffalo bugs carpets must be taken up and floors (especially the cracks) well treated with an alum, salt and turpentine mixture.

Destruction should always begin when the first bug is noticed. They multiply very rapidly, and the neglect of the first proof of their presence may result in their overrunning the house, in which case complete "doing over" of several rooms may become necessary, including painting, whitewashing and papering.

**COCKROACHES.** Cockroaches are large, dark-brown beetles which love damp, filthy places around water-pipes in the insides of houses.

Absolute cleanliness and sanitary arrangements which leave all damp places open to the sunlight, are almost sure preventives.

There is no better poison than powdered borax mixed with powdered sugar and scattered all over their runways and forced with bellows into the cracks and crevices. It kills them, but is harmless to people and to pets. A mixture of 3 parts of flour with 1 part of plaster of Paris is effective. Set a low, flat dish containing this mixture where the roaches can reach it, and near it place a saucer of water.

Whatever destructive measures are used, the roaches will return constantly unless all dark, damp places are done away with and all damp cloths, mops and so forth hung out in the sunlight.

**BLACK AND RED ANTS.** These little creatures sometimes become so numerous that they are the despair of housewives, swarming over foodstuffs, particularly meats and sweets.

Powdered borax, gum camphor, or red pepper kept near the food will drive them away. They are not likely to climb on shelves or tables, or to enter refrigerators or drawers which are frequently washed in carbolic soap. A further precaution is to place the legs of tables and refrigerators in pans of water over which is poured a tablespoonful of kerosene. They will not go beyond these.

They may be trapped by baiting thread or sponges with molasses and burning these when the ants are swarming on them. Many other ants, however, will come to the funerals, and the only thorough method is to destroy the nests. Locate these by placing coarse sugar where the ants will find it. Soon they will begin to carry loads to their homes. Take up a few boards or stones where the ants are seen to enter, and find the nests, then inject an ounce or two of carbon bisulphide and cover it up solidly with earth. The nests of red ants are usually in the walls or floors of houses, those of black ants under stones in the yard.

The carbon bisulphide will spread out into all parts of them and destroy the colonies. It is not expensive. Care is necessary in the use of carbon bisulphide in a closed room, as the gas formed is highly explosive when it comes in contact with fire.

**WHITE ANTS.** These are not ants at all, though they look like them and in many ways act like them. They are common in all parts of the United States, but they do their worst damage in hot, moist localities. They are vegetarians, eating decayed wood, paper, books, and other material. They enter these and eat from the inside out, so that their food sometimes crumbles into powder before an "ant" is seen.

New buildings in places where these insects work should be set up on cement or stone foundations, and approached by gravel or asphalt walks, not board walks. Exposed timber and wood should be sprayed frequently with creosote. Paper must not be allowed to accumulate and books ought to be frequently examined.

The only method of getting rid of these pests seems to be to fumigate with hydrocyanic acid gas. (See Vol. II, p. 511.)

**CHIGGERS** though not really household pests, frequently prove very annoying to the members of the household. Not only are these little trouble-makers found on the grass and weeds in pastures or timbered tracts, but also sometimes on well-kept lawns.

Take a bath in hot water, to which strong soap or salt has been added, very soon after exposure to chiggers. However, after the lapse of a few hours, and after irritation has set in, such a bath will do no good. To treat each red spot with a strong solution of ammonia will then help. A well-saturated solution of bicarbonate of soda, or common cooking soda or saleratus may also afford relief. Where the suffering is very bad, a dilute tincture of iron or collodion should be applied.

**MICE.** With mice, as with many other pests, it is easier to keep them out of the house than to get rid of them once they are in. So the house should be built so as to prevent mice from getting in. Where there is a basement under the house, the windows should be screened as mice often get into the upper part of the house by coming from the cellar. Rat and mouse guards should be put in the walls at each floor so as to prevent these pests from climbing up between the walls.

In old houses and others that are not entirely mouseproof, nothing in the way of food should be left exposed to mice. Surplus meat left in the pantry, popcorn, beans and peas and dried seeds, unless covered or hung out of reach, are almost sure to attract mice. Keep all trash and rubbish cleaned up. Use the little spring traps, baiting with cheese, whenever a mouse is known to be in the house.

**FLEAS.** In many places, especially where hogs and other live stock are bedded in buildings near the farm residence, fleas become serious pests. On some farms, fleas are so numerous during the summer months that it is almost impossible to make the ordinary use of barns, stables and other outbuildings where stock is kept. Not only do the fleas prove a great annoyance to the men whose work takes them into the farm buildings, but getting into the clothing, the pests are carried to the house. In this way the whole family is annoyed. Dogs also carry the fleas from stables and sheds to the farm residence.

Once a farm building has become filled with fleas, getting rid of them is no easy matter. For the sake of the comfort of the family, the first thing is to prevent the pests from getting into the dwelling house. Dogs and cats frequenting buildings where fleas are plentiful must be kept away from the family residence, even off the porches. Nor must the children be allowed to play with these pets, which should be bathed occasionally in water containing about a dozen teaspoons of creolin to the gallon, or dusted with Persian powder. When fleas are very bad in the barns, it is often best for the man who has to look after the stock to change his clothing before going into the house.

The first thing to do in ridding a barn, shed or stable of fleas is to clean up. All rubbish and bedding should be removed and burned.


FIG. 206. Rats are not only a source of loss but also of great danger, on account of the diseases they carry

If manure has been allowed to accumulate, it should be hauled out. Floors, partitions and other woodwork should be thoroughly sprayed with a coal-tar or carbolic-acid mixture. It may be necessary to spray several times. Use whitewash wherever possible.

After the building and surroundings have been thoroughly cleaned, they must be kept clean. Doors and windows should be opened so as to let in plenty of air and sunshine. Where a clean-up is undertaken, it will do but little good unless it includes all the buildings where fleas are known to be bad.

**RATS.** The rat not only destroys property to the value of many thousands of dollars each year, but also endangers human life and public health.

FIG. 207. The snap or guillotine trap is a most effective rat catcher.

Rat riddance is no easy matter, as the pests go from farm to farm and from neighborhood to neighborhood. The means for ridding a farm of rats may include: (1) driving out the rats, killing as many as possible and destroying harboring places; (2) starving, in so far as can be done, by ratproofing cribs and bins; (3) trapping, poisoning, and using rat dogs; (4) preventing multiplication.

Almost every one who has lived long on a farm, especially in the corn belt, can recall some day when the men and boys on the place joined in a general rat killing. On the day when such a big drive is made, rats are dug out wherever they are found, provided it is possible to get to the runs. Where the harboring places cannot be reached, unslaked lime or chloride of lime is placed in the openings. For killing rats by wholesale in their homes in the ground, carbon bisulphide is the best agency known. Put in the runs, which are then closed, it forms a deadly gas. It should, however, never be used in or about buildings where there is fire, as it is both explosive and inflammable.

**Rat-proof buildings.** With the passing of the log barn and the wider use of cement in barn building, rats are not as great a nuisance as they once were. The full concrete foundation and rat-proof cribs and granaries are making the farm buildings less inviting to rats. The wider use of coal as fuel and the displacement of the old-time rail fence, with surplus rails piled about the lots, are also helping in the fight against rats. Where cribs, granaries, meat houses and poultry houses are not made rat-proof, the floors should be some distance above the ground so as not to make hiding places for rats.

**Trapping and poisoning.** Rats are often cunning and suspicious and hard to trap. However, with so many kinds of traps on the market, it is possible to catch many of the pests. The first thing in trapping rats is to cut off the natural food supply just as far as this can be done. The next thing is to set the trap as it should be, first being careful to remove any odors which might tend to keep the rat away. If the trap is new or if rats have just been caught in it, a good plan is to hold it in a dense smoke in order to take away the odor. Some trappers make use of a single drop of oil of anise or caraway to scent the bait or trap. Various baits, such as fish, cheese, bacon, scraps of raw or cooked beef, and even vegetables, are used. It is well to use various kinds of bait and to provide some food that the rat is not getting in its daily foraging.

Poisons, while fairly satisfactory in killing rats, should not be used except with great care. Poison must be kept out of reach of children, must not be left where grown people will get it by mistake, or where birds or domestic animals might eat it. Where poison is used it should be put well back in the run by means of a long-handled spoon.

Many kinds of rat poison are on the market. There is also what is known as the official arsenical rat poison, which has been extensively used by the Public Health and Marine Hospital service of the United States. Directions for making are as follows, but for use on an ordinary farm one tenth of the amount would probably be enough:

| | | |
|---|---|---|
| White arsenic, very finely powdered | 4 | pounds |
| Cheese | 4 | pounds |
| Glycerin | 6 | ounces |
| Water | 1½ | gallons |
| Corn meal | 10 | pounds |
| Black aniline | Sufficient to color to a slate gray | |
| Oil of anise | ½ | ounce |

Melt the cheese with the glycerin and one half gallon of the water, then add the corn meal and the rest of the water, and continue to heat until the corn meal is thoroughly cooked. Then stir in the arsenic and black aniline, and lastly add the oil of anise. It may require more or less water for the above formula, according to the amount of starch in the corn meal, but the quantities as given above are for average quality of corn meal.

It should be borne in mind that regardless of what poison is used, the dying rats may get into the walls of the dwelling, unless these are rat-proof, or even the cistern unless it is properly protected. A rat may get into or under the dwelling and die in a place where it cannot be reached. Something to destroy the odor is then in order. A compound of zinc and chlorine, commonly known as chloride of zinc, may be used. The following has also been recommended: In 1 pint of boiling water, dissolve 1 teaspoonful of nitrate of lead; next dissolve 2 teaspoonfuls of common salt in a bucketful of cold water, then mix the two. Next dip a good-sized cloth in the mixture and hang in the room.

A fox terrier or other dog that is a good ratter will help in keeping a farmstead free from rats. The ferret, a small weasel-like animal useful in killing rats, has been used but little on the farm.

# D. SICKNESS: ITS PREVENTION AND CARE

*By* BAB BELL, *who writes on Household Hygiene, and* MRS. H. J. KEYES, *who discusses the important, often vital, subject of the Care of the Sick. Because of its location, the condition of country roads, the lack of correct information on the part of its occupants, and other disadvantages, the farm home has long been out of touch with adequate medical care and attention. Conditions are now improving rapidly, partly because of the wider use of the automobile, partly because of better roads, and partly because of the spread of modern knowledge by county agents, extension departments and other educational agencies. However, the farm woman must always be prepared for emergencies; accidents will happen and trained nurses are often unavailable especially in the early stages of disease when correct attention is most important. This chapter is not a medical guide or "home physician"; it simply tells what the farm family can and should do to keep its ill or injured members most comfortable until expert care can be obtained.*—EDITOR.

## Household Hygiene

(*By* BAB BELL)

Every woman who presides over a home should have a knowledge of household bacteriology, and the relation of bacteria to disease.

Bacteria, yeast, and mold are tiny plants. The reason it is difficult to keep foods is that millions of these small organisms are everywhere present. When an article of food "spoils," it means that bacteria, yeasts or molds are causing the change. The housewife should understand that diseases are caused by certain forms of such micro-organisms. One of her problems is. therefore, the control of these organisms.

*Bacteria* are the smallest and simplest forms of plant life known, and are the most universally distributed. There are hundreds of varieties, but fortunately only a few produce disease. Different kinds vary in size. It takes about 20,000 of the smallest bacteria to cover a pinhead. Many bacteria are harmless and may be made useful. For example, the pleasant acids of buttermilk, vinegar and sour milk are due to bacteria. Other bacteria develop in meat and fish, and produce substances known as ptomaines, which are dangerous.

*Yeast plants* in bulk are most familiar to us in the yeast cake which contains millions of yeast plants massed together. Yeasts are useful in bread making, and they also cause fermentation of fruits. When the yeast plants are introduced into the dough, they break up part of the sugar into alcohol and carbonic acid gas. The gas expands, and this causes the loaf to be light. The same thing happens when the yeast falls upon our canned fruits, only the fermentation ruins the taste of the fruit.

Masses of *mold* may be seen with the naked eye. The spores (or seeds) are everywhere present, and need only warmth and moisture to enable them to grow. The most familiar examples are mold on fruit and bread, and mildew on cloth.

The problem of the housewife is to control the growth of these organisms. This is possible if the following points are kept in mind:

1. With warmth, moisture, and food, all organisms will flourish; most of them also require air, but a few do not.
2. Intense heat kills all organisms; boiling temperature (212 degrees F.) will kill everything except spores. To kill spores, continuous heat for some time is required, and some spores require repeated applications of boiling temperature.
3. Cold retards the growth of organisms but does not kill them.
4. Micro-organisms (a term used to designate all organisms so small that they can be seen only by the aid of a microscope) do not develop on dry material. Moisture is necessary for their growth.
5. Most micro-organisms are killed in a few hours by direct sunlight.
6. Dust is comparatively harmless in itself, but is a means of conveyance for micro-organisms.
7. Micro-organisms cannot live in a concentrated sugar solution. This explains why fruit keeps when made into preserves, even though not sealed.
8. Micro-organisms cannot live in a concentrated salt solution, which explains why a salt pickle is successful.
9. Micro-organisms flourish in food products that contain only small quantities of either sugar or salt.
10. Vinegar, spices and wood smoke tend to prevent growth of micro-organisms.

Of what value is the knowledge of these facts to the housewife? Just this: The housewife is held responsible for the health and happiness of her family; she buys and handles the food eaten by the family, and should know the possibility of transmitting disease by foods. Also, she can apply her knowledge in other ways.

**Personal cleanliness comes first.** Every housewife should endeavor to maintain a high standard of dress and hygienic surroundings in her kitchen. The dress should be of wash material, rather than woolen. The hands should be well washed and the nails cleaned. When handling food, clean nails are a safeguard from disease. Caps are recommended to protect the hair from odors of cooking as well as to protect the food from falling hair. Testing by means of placing the finger in different food materials is not only dangerous as a disease carrier, but it is nauseating. Coughing and sneezing while preparing various foods, without using a handkerchief, is inexcusable. The fine particles of sputum which fly from the mouth contain germs of disease. The nail brush and hand brush should be used before mixing bread or cake. Many factories have been compelled by law to clean up, and some are cleaner than are many of our own kitchens.

**The care of food in the kitchen, pantry and dining room is important.** This work is greatly aided by proper utensils and conveniences. The following sanitation points should be kept in mind.

1. The kitchen, dining room and pantry should be kept as free from dust as possible. Left-overs should be properly cared for. Foods left exposed to the air, uncovered, form a good stronghold for the collection of disease-producing germs; moreover, the practice is also very unsanitary.
2. Careless dishwashing may be a means of transmitting disease. If dishes are rinsed in boiling water, drying will be unnecessary and the dishes will be partiallly sterilized.
3. Dish towels should be frequently washed and boiled.
4. Pet animals should not be allowed in the kitchen. Aside from the fact that they leave more or less loose hair and dirt, they are also known to be carriers of disease.
5. Mice and rats not only destroy foods but have also been known to transmit diphtheria and other deadly diseases.
6. The house-fly should be looked upon as the most deadly disease-carrier with which the housewife has to contend. She should make every effort to keep it out of the house, while the farmer should carry on a constant campaign to prevent its multiplying in and around the barn.

**How to destroy disease-producing organisms.** Disease-producing organisms may be controlled by common household methods which every woman has at her command: namely, sunlight, frèsh air, soap and water, and boiling water. Some simple and inexpensive chemicals may also be used.

Generally speaking, too much importance is attached to some so-called disinfection. Recent investigations have shown that sunlight, fresh air, and soap and water are the best agents that the housewife can employ in killing germs. Of course, everything that can be boiled without injury to the article should be disinfected in that way, as boiling in water is a sure method of killing disease germs. The housewife who lets into her home all the sunshine and fresh air possible and who uses soap and water freely, is employing the best disinfectants known. Cleanliness will help to prevent disease.

## The Care of the Sick

*By* MRS. HELEN JOHNSON KEYES, *who, in preparing this article has had, in addition to her own knowledge and experience, the assistance of her husband who is a physician, at present writing in the U. S. Medical Reserve.*—EDITOR.

Doctors give fewer drugs than they gave years ago and depend more upon good nursing carried on under their directions. Consequently, the work of the home nurse no longer is chiefly made up of administering medicines at certain hours.

**Conditions and symptoms.** The doctor is grateful when the nurse, be she a trained and paid helper or merely an untrained relative of the patient, can give him in a few words just that account of the invalid which will assist him in understanding her condition and prescribing for it. The important symptoms may differ slightly in different illnesses, but there are certain things that the physician will always want to know, and he will be glad if the nurse has these written on a piece of paper. Temperature, pulse, breathing, amount and kind of nourishment taken, and the digestive processes are what he needs to know about. The nurse, therefore, must understand how to report these.

**Temperature.** The normal temperature is between 98 and 99 degrees Fahrenheit. From 100 up to 103 degrees is a slight fever, from 103 to 105 degrees a high fever. Fevers in children run higher than in grown people, but fall more rapidly and are less alarming. A temperature below 98 degrees is called subnormal and is occasionally seen in wasting

diseases or after severe bleeding. The temperature is taken by means of what is called a clinical thermometer. Before using the thermometer, the strip of quicksilver which passes through it must be shaken down to below 98 degrees, if it stands above that. Exposure to the temperature of the room will not bring it down. A quick, sharp jar by the hand which holds it is necessary. Then it must be dipped in pure alcohol or a solution of borax (1 teaspoonful to a glass of warm water) to insure cleanliness. It is put either in the mouth under the tongue (and the patient told to hold her lips closed), under the armpit, or in the rectum. In the case of children the latter method should be used to avoid danger of biting and breaking the glass, and also for the sake of accuracy, as a young child can not keep the thermometer steady under the tongue and with lips closed. In this case the end should be greased with vaseline or sweet oil and inserted about an inch. Most thermometers need 2 minutes to record the temperature. Of course, no lengthening of the time they are in position will cause the mercury to rise higher than the temperature of the patient. It is well to read the thermometer at once after removal, but if you are called away before doing so, the mercury will remain at the same place, not falling until it is jarred down. To read, stand facing a light; hold the thermometer on a level with your eyes, the sharp angle toward you and with the figures below visible. Keep shifting, if necessary, till you see the flat band of quicksilver stopping sharply at a certain figure, which figure is the temperature of your patient. Wash the thermometer in soap and water before putting it away. Temperature should be taken several times a day during illness, and recorded on paper, together with the hour when it is done.

**The pulse** is the throb of the bloodvessels, occurring whenever a beat of the heart fills them. It can be felt best 2 inches below the base of the thumb. Here is a table of pulse beats at different ages, during health: At birth, 130 to 150 per minute; 1 year, 110 to 130; 2 years, 90 to 115; 3 years, 80 to 110; 7 years, 70 to 90; 12 years, 70 to 80; 15 years and after, about 70. They may be irregular without causing anxiety, but if very hard and tight there is probably some trouble. Ordinarily the pulse increases several beats a minute with every degree of fever; but typhoid, on the contrary, makes the pulse slow. The pulse should be "taken," as the expression is, at the same time as the temperature and recorded on paper for the doctor. It is done with a watch in the hand to mark the passing of just 1 minute, while the number of pulse beats during that minute are counted.

**Respiration or breathing.** Each breath represents our intake of air to the lungs and its escape again. You have probably noticed how rapidly a little baby breathes. It sounds alarming, but, as a matter of fact, this is as it should be. The following normal rates at different ages show the gradual slowing of respiration as we grow older. At birth, 35 per minute; 1 year, 27; 2 years, 25; 6 years, 22; 12 years and after, 20.

Certain diseases increase the number of breaths we draw. In pneumonia, they run up to between 40 and 60. Other conditions make the number less. Poisoning of the system (known as septic conditions or *septicemia*) has this effect. When breaths become as few as 10 to the minute, grave danger is indicated. There is another alarming kind of breathing which is named "Cheyne-Stokes respiration." It consists of deep, sighing breaths, followed by long pauses.

**Nourishment.** The kind and amount of nourishment taken is a fourth matter to be reported to the doctor, together with the hours it was given and the pleasure or displeasure with which the patient received it.

**Digestion and elimination.** The activities of the bowels and bladder are of importance, and must be accurately recorded. The tongue should be of a clean, reddish-pink color, and if coated with gray, the doctor should know about it.

**Unfavorable symptoms.** Certain rashes start on the cheeks inside the mouth. The doctor should be told if any such condition appears. The skin of the face and body should be observed and the doctor informed of any unnatural condition. A bad-smelling breath means that help is needed. Restless sleep must be reported.

**Medicines.** We have all read of the accidental poisoning of sick people by the nurse in charge. In order to avoid such an accident, make it a rule never to give any medicine without reading the label on the bottle or box. Be careful that the writing on the label does not become blurred. Tinctures need to be placed in a dark cupboard. Keep medicines for rubbing and external use apart from those taken through the mouth. People have been known to fill old medicine bottles with poison, and not remove the former label. This wicked carelessness has caused many deaths. Keep all medicines out of reach of children.

Tight glass stoppers may be loosened by holding them under steam or by allowing a few drops of oil to stand in the crack. All medicines should be shaken before using, and corks should be kept tight. Those which are given by the drop should be measured from a medicine dropper, a tiny glass tube with a rubber bulb which allows but one drop to fall at a time. The following table will help in understanding quantities ordered: 1 teaspoonful equals 1 dram; 1 dessertspoonful equals 2 drams; 1 tablespoonful equals 4 drams; 2 tablespoonfuls equal 1 ounce; 1 teacupful equals 4 fluid ounces: 1 tumblerful equals 8 fluid ounces.

**The nurse and her patient.** Now let us consider how to make a sick person comfortable. This is the relation of the nurse to her patient, the art of nursing.

Room. When an illness is contagious, a room or rooms must be sought for as far away as possible from the part of the house in which the rest of the family live. The sick rooms must have their own service of linen and dishes, which are disinfected before they are carried out. Carpets, upholsteries and draperies must be removed, and only such furnishings remain as can be washed with disinfectants. The mattress either must be covered by a rubber sheet, or else destroyed at the close of the illness.

When the malady is not contagious, the most cheerful room in the house should be chosen. Sunshine is extremely important. Ventilation must be thorough and may be secured by 2 windows, one open a little at the top for the escape of bad air, and one at the bottom for the entrance of clean air. If the blood is not cleansed by the passage of clean air into the lungs, recovery is slower and less complete. A screen, or a clothes-horse hung with a blanket, is a necessary protection from drafts. The temperature ought to remain during the day at about 66 or 68 degrees Fahrenheit and at 55 degrees through the night. In order to insure its doing so, a reliable thermometer should be in a convenient place for reading. A cheerful outlook will help a patient who is recovering, and although the bed must not face the light, it may be drawn into a position from which the patient can see out. Shades are needed to regulate the light. When these are lacking, the panes can be soaped. Carpets and draperies are objectionable on account of the dust raised in cleaning them. Only floors and surfaces which can be wiped with damp cloths are to be recommended, for the room should be kept absolutely clean. Flying dust is actually dangerous to a patient. Flowers bring much cheer, but they should not have heavy odors, nor be allowed to remain after they commence to fade. At night it is best to set them outside. No worries, no problems should be brought to the sick room. Noise, whispering, and fussing are bad. The nurse must act quietly, quickly and decisively, though gently and kindly. Few neighbors should be admitted, and among them only those who are both cheerful and quiet. Even their visits should be short, and the nurse should ask them courteously to leave after 10 or 15 minutes.

**The bed.** Nursing is made easier when the bed is raised on blocks to a height suitable to the stature of the nurse. It should stand out from the wall; a single bed is taken care of with less effort than a double one. Newspapers protect the mattress, and can be changed whenever cleanliness demands it. The lower sheet should be tucked firmly under the mattress at the top, even though it scarcely reaches the bottom, and then secured at the four corners with safety pins. Over this the doubled draw-sheet passes across the middle of the bed from side to side and is pinned to the under part of the mattress. This draw-sheet may have rubber under it, if called for. The under sheet will thus remain clean for some time, while the small draw-sheet can be changed with little effort. The remaining bed clothes need firm tucking in at the foot. A piece of dimity or calico will protect the blankets, and be lighter on the patient and easier to wash than the usual counterpane.

In the case of a long illness, when the mattress tends to sag in the middle, a blanket may be folded and laid under the sagging part across the springs. When the weight of the bed clothes annoys the patient, they can be held up by three barrel staves. Pillows should be so arranged as to support the back and shoulders without thrusting the head forward. Bed sores may be guarded against by bathing the back with vinegar. If a sore appears, cover it with white of egg. Then protect it from pressure by making a ring of twisted newspapers wound with cheesecloth. Ordinary chafing is relieved by powdering with pulverized laundry starch or corn starch.

**Bathing and the morning toilet.** The comfort and wellbeing of the patient require a sponge bath in bed each morning, 2 hours after eating. To do this, place a blanket under the invalid. With water at about 96 degrees, unless otherwise ordered, and with a soaped cloth not wet enough to drip, bathe the patient by sections. That is, keep all the patient's body covered except the part that is being bathed. Slip one arm, for instance, out of the nightgown and expose it just long enough for washing in soap and sponging off in clear water. The use of an extra blanket will make it easier to protect the portions of the body close to the areas being bathed. If not too ill, the patient can turn on her side, allowing her back to be reached, and can put her knees up and her feet in a basin or tub of water placed on the bed.

In changing nightgowns, the soiled one can have the running string in the neck loosened so that it will slip off at the feet while the clean one is put on over the patient's head, thus avoiding exposure. Unless a clean nightgown can be supplied each day, it is a good plan to have 2 in use; each can be worn one day and aired the next.

**Care of teeth and hair.** The teeth should be brushed at this time and the mouth rinsed with a teaspoonful of peroxide of hydrogen or

4 drops of pure alcohol in half a glassful of water. If the patient is a woman, her hair needs a gentle brushing and combing and is best taken care of in two braids.

**Making the bed.** When only the upper sheet is changed, the covers are loosened from the bottom and sides, the clean upper sheet is inserted over the old one, tucked in at the foot, and held firmly with one hand while the soiled sheet is pulled out. When the under sheet and draw-sheet require changing, move the patient to one side of the bed, loosen all the covers, and from the unoccupied side roll the soiled undersheet and draw-sheet along widthwise against the patient. Insert the clean sheets over the free space and bring the patient back to that side of the bed upon them. The old sheet is then free, and can be removed, and the new ones drawn across smooth and tight, tucked in, and pinned. In the case of a helpless invalid the bed clothes are worked from up at the head and down at the foot of the bed by two people and the patient is gently raised while the clothes are passed under the hips. To lift, two people should stand on the same side of the bed. One supports the shoulders and brings her arm under the further arm of the patient; the other places one arm under the hips, the other under the knees.

**How diseases spread.** Most illnesses, except those due to accident, to the advance of old age, or to poor nutrition (poor food or poor handling of food by the body), are produced by germs and may be passed on to family and neighbors. The ease with which the germs are carried—called contagiousness—varies in different diseases. Germs also get into the system in different ways. The typhoid germ, for instance, comes through something that we eat or drink. Most germs can be breathed in, and some enter through scratches, cuts, and open wounds. When there is a disease in your neighborhood, it is a good plan to find out how it is "caught," how soon after exposure to it the sickness develops (this time between exposure and active sickness is called in medical books, the "period of incubation"), and what the first symptoms of the disease are. This is very important in the contagious diseases of childhood.

**Many drugs are dangerous.** Never give medicines to your family or yourself just because doctors have prescribed them to your neighbors. Your constitution may not be at all the same as your friend's. Beyond all, remember that drugs act upon children very differently from grown-ups, and that certain ones never must be given them, even in small doses. Only the doctor should prescribe medicines. As for patent remedies, many of them are fakes, amounting to little more than flavored water, and many are yet worse, full of harmful, habit-forming drugs, such as morphine and alcohol. These may quiet the symptoms of the disease for a time, but do not cure it. A few are reliable and useful preparations under the right conditions, but a doctor is usually needed to decide whether you are suffering from the troubles which they will help.

**What to do while waiting for the doctor.** When no doctor can be had, or when a long delay must occur before his arrival, there are many things which a sensible nurse can do.

In the case of *chills, exhaustion, pain in the joints, inflammations, electric shock, lightning stroke, and colds and grippe where there is not a fever*, hot-water bottles, heated bricks or hot bags of salt should be used to warm the patient, who, of course, must be put to bed. Hot milk may be given. In the case of chills, the heat must be gradually removed as the hot period approaches, and when the sufferer begins to perspire, the skin should be wiped dry gently from time to time, and powdered with rice-powder, starch, or corn starch.

*Unconsciousness* which is brought about by a blow on the head, requires cold applications—ice, if possible—at the head, and hot ones at the lower extremities.

*Headaches and sleeplessness* are often relieved by mustard foot baths, lasting 20 minutes. A tablespoonful of mustard is required for a gallon of warm water. The tub must be supplied with more and more hot water as the supply cools, and the legs kept snugly covered with a blanket.

*Epilepsy* can not be controlled. A soft cloth should be placed between the teeth, to prevent biting the tongue, and a pillow should be placed under the head.

*Convulsions of babies* are best treated by

mustard baths, made by mixing 4 or 5 tablespoonfuls of dry mustard in a gallon of warm water. The child should remain in it until the skin is red. After complete recovery from the attack, a high injection of warm, soapy water into the upper bowel is called for. This is done by adding rubber tubing to the usual fountain syringe and putting it up from 6 to 12 inches into the bowel.

Most of the sudden illnesses of little children are caused by *indigestion*. A warm water injection will often bring down a high temperature at once. Food should not be given at all for several hours, and then only liquid food in small quantities, until complete recovery.

*Bleeding from a wound* can usually be controlled by pressure over the wound, or by a very tight bandage above or below it. When the blood from a wound comes in spurts and is rather bright red, it is probably from an artery. If so, the bandage should be placed between the wound and the heart. Where the flow of blood is slower, regular and the color somewhat darker, the indications are that it is from a vein. In this case the bandage should be placed beyond the wound—if on an extremity, such as arm, leg, hand or foot—instead of between the wound and the heart.

*Nose bleed* is sometimes checked by pressure on the upper lip at the base of the nostrils. A cloth which has been dipped in cold water may also be applied at the back of the neck. Another treatment is to hold the head erect and place a clean cotton plug or one soaked in peroxide of hydrogen, in the nostril.

*Hiccoughs* are stopped by a few drops of vinegar on sugar.

**Burns and freezing.** In case your clothing catches fire, do not run out into the open. If the fire cannot be put out in any other way, lie down and roll over and over on the floor. In attempting to put out a fire in the clothing of another person, smother the blaze by throwing round him a blanket, coat, or anything woolen that may be near at hand. In any burn the first thing to remember is to exclude the air. Do not open the blisters. In case of severe burns call a physician. The burn may be covered with a poultice of common baking soda or with a cloth coated with linseed oil.

In severe winter weather, we may freeze our ears, nose, toes, or cheeks. The frozen part first feels cold, then turns red and later feels as if going to sleep. At the same time the color changes to a dark red, and later all color leaves and the frozen part becomes white. Under these circumstances keep away from the fire or a warm room. Put the frozen part in a bucket of ice water or rub briskly with wet snow. As soon as feeling returns wrap in cloths that have been wrung out in ice water.

**Fainting and sunstroke.** The first thing to do when a person falls in a faint is to place his head lower than his body. Open his clothing about his neck and chest, and sponge his head and face with cool water. Do not allow people to crowd about him as this cuts off the air.

Heat exhaustion and sunstroke usually occur in extremely hot weather. In the case of heat exhaustion, the skin is cool to the touch and is damp; the face is pale, and the breathing is shallow. In heatstroke the skin is very hot and dry, the face is very red, and breathing is deep. Also in heatstroke the victim is usually unconscious. In treating for heatstroke, place the patient in the coolest place possible. Pour cold water over the body, and if ice is to be had, use it in rubbing the body all over. As soon as the victim becomes conscious, give him cold water, but not ice water, in small quantities. In case of heat exhaustion, place the victim in the shade, open his clothing round his neck, and lower his head, give him black coffee or other stimulants. Then wrap him in blankets and rub his limbs until they feel warm.

**First aid in drowning.** After getting the person out of the water, the first thing is to get the water out of his lungs. In doing this open his clothing about his neck, turn him on his face, then stand astride him and pick him up by placing your hands along his body just above his hips, and lift him so that his face falls towards his toes. Hold him in this position and shake him up and down several times. Bear in mind that the first object is to get the water out of his lungs so air can get in. It is well to wipe out his mouth as it may have been filled with mud or sand or phlegm.

The next thing is to start him breathing. In this lay him face down, turn his head to one side so that the nose and mouth are not in the dirt. Bring his arms straight up above his head, get astraddle of his legs up close to his hips and place your hands under the lower edge of the lowest rib, turn your hands outward so your fingers point away from his backbone. Then put the heels of your hands on his back 2 or 3 inches from his backbone, having one hand on each side of the backbone, and the little finger of each hand along the lower edge of the lowest rib on each side. Then keep your arms straight and throw your weight forward on your hands and stay in the position for about 3 seconds. Suddenly remove your weight, then wait 2 or 3 seconds and again put on the weight. Keep up this movement 12 or 15 times a minute until breathing has been started. After this as soon as the victim is conscious, give him something hot to drink and wrap him in blankets so as to keep him warm. Watch him carefully to see that he does not stop breathing.

**Sprains and fractures.** In case of a sprained ankle or wrist, put hand or foot in a bucket of cold water at once. Keep adding cold

water, or ice water is better if it can be had. Keep the limb in water for about a half hour, bandage tightly, and as soon as possible consult a physician.

In case of a broken bone, see that the injured limb is not moved more than is absolutely necessary; try to keep the limb in a natural position and hold it there by use of splints.

For splints, use pieces of boards, sticks or anything strong enough to hold the limb so it cannot move. The main thing is to put the splints on tight enough so that there can be no movement of the broken ends of the bone, yet not so tight that they will cause pain or pressure. In placing the splints, pieces of cloth or anything soft may be used for padding. Consult a doctor as soon as possible.

Poisoning. In treating for poison, the aim is either to get the poison out of the system or give something that will change it so it will no longer act injuriously. To get the poison out of the system, the first thing to do is to empty stomach by causing vomiting. To do this, give a glass of warm water with a teaspoonful of salt in it, or a glass of warm water with a teaspoonful of mustard in it. Then put your finger down the victim's throat as far as you can, or tickle the back part of his throat with a feather until he vomits. Give water from time to time so as to keep him vomiting until the water he throws up is clear. There are times, however, when we should not give him something to make him throw up. If there are burns on the lips or in the mouth, this indicates that carbolic acid or some other strong acid has been taken. The proper treatment then is to give hot strong tea, milk or white of egg.

Every poison has its antidote—by which is meant its remedy. The following list shows some of the common ones:

For *poisoning from opium, laudanum and morphine*. An emetic should be followed by strong coffee, or the white of an egg. Keep the patient walking for two or three hours.

For *poisoning from arsenic, corrosive sublimate, verdigris, blue vitriol, and vegetables kept in copper vessels*. Give an emetic and the white of an egg, sweet oil and milk.

For *sugar of lead poisoning*. Give an emetic and Epsom salts.

For *poisoning from hemlock, aconite, belladonna and foxglove*. After emetic give tannin and stimulants.

For *strychnine*. First give an emetic, and then a large dose of bromide of sodium (60 grains in solution). Repeat every hour until three or four doses have been taken.

For *toadstool poisoning*. Give emetics promptly, then castor oil and stimulants. Apply heat.

For *poison ivy or oak*. There are three generally effective remedies for poison ivy or mercury. One is to apply hot water to the poisoned surface. Another is peroxide of hydrogen. The third is a solution of sugar of lead, about 40 grains to a pound of water. Two other remedies that are more or less effective are baking soda and dry starch.

Warm salt and water to produce vomiting is desirable. If the mouth and throat are burned, tepid milk and white of egg are soothing. Poisoning by gases is treated with fresh air, and by artificial respiration if the condition is so serious as to amount to unconsciousness.

When a person has been bitten by a poisonous snake, place a tourniquet without the pad between the wound and the heart. Then with a clean knife blade make the wound from the bite larger so that blood will flow from it. An ordinary knife blade may be made safe by first holding it in a match flame. After opening the wound, have the injured man or some one else suck the wound, then follow with stimulants.

**Miscellaneous Measures.** *Fevers* may be reduced by sponge baths at 15-minute or half-hour intervals with water at a temperature between 70 and 85 degrees.

*Stimulation* will result from bathing in water between 98 and 110 degrees. One fourth of a pound of rock salt added per gallon will increase the invigorating effect.

*Bran baths* often relieve eczema and other irritations of the skin. Half a pint of wheat bran is put in a bag made of cheesecloth or coarse muslin and stirred about and squeezed in one gallon of water at about 95 degrees, till the water is like thin porridge.

*Poultices* are very little used in these days, having been generally replaced by wet dressings, called *fomentations*, for the relief of inflammations.

These are prepared by soaking a white flannel cloth in boiling water (which may sometimes be medicated, but often is not) and laying this steaming flannel quickly in a towel, where it can be wrung almost dry without burning the fingers. It is then taken from the towel and applied to the inflammation from which the patient is suffering, and covered with another flannel and, if possible, also with a rubber cloth or oil silk, to retain the heat.

A *mustard fomentation*, used for the same conditions for which a mustard plaster was formerly prescribed, is made by adding 1 tablespoonful of dry mustard to a pint of hot, but *not boiling* water.

A *flaxseed fomentation* is made by stirring into boiling water enough flaxseed to thicken it till it drops from a spoon.

When, after an accident, a deformity appears between joints, it usually means there is *dislocation*. Gently pull the member straight and put it between 2 boards wider than it is. Bind the boards together and send for the doctor.

*Artificial respiration* should be used (as soon as heat and dry garments are secured) in cases

of electric shock (which includes lightning stroke) and drowning. For this treatment the patient is placed on his back and his tongue pulled forward and held there with a clean cloth. His arms are then grasped by the shoulders, brought together over the head, circled downward to the chest, against which they are pressed to force out the air. This should be done *slowly*, about 20 times to the minute, till life is fully restored.

**Diet, or food for the sick.** Diet is a matter of the utmost importance. Nourishment should be given with absolute regularity, at short intervals and in small quantities. It should be brought to the bedside on a dainty tray in attractive dishes. What is left should be removed immediately.

It must be remembered that there are certain disturbances of the stomach and intestines during the most serious stages of many diseases when no food should be given. When the digestive tract is in such a condition that it cannot take care of what is put into it, but at once gets rid of it by vomiting, food does no good but may do harm. Under such conditions, there is no remedy like doing without all food. Do not be afraid, in these extreme cases, to continue starvation for as much as 48 hours. This is specially true with babies and young children, who are frequently fed to death in illness.

There are 3 kinds of diet ordered for sick people: liquid, soft or light, and solid. The following lists will show what is meant by each of them and supply suggestions for pleasing and nourishing the invalids who come into our care:

Liquid diet, as a rule, is given at 2-hour intervals. It is the diet ordered for the very sick, and milk is its most valuable article. From half to three quarters of a cup is the usual amount taken at a feeding in the case of all these drinks, which include hot and warm milk, hot cocoa, beef juice, chicken broth, beef broth, oyster broth with milk, egg-nog, hot tea and hot coffee, with milk and a little sugar.

Light diet includes the foods given in liquid diet, and adds to them: soft-boiled, poached, and scrambled eggs; granum or farina porridge; farina mush; cream of vegetable soups; milk, cream or dry toast; custards; grapes and oranges; homemade ice cream; jellies; and *very light* puddings. Usually five light lunches a day are given, with not more than two articles at a meal.

Solid or convalescent's diet. This makes use of the articles given under liquid and light diet, and adds: broiled and roasted meats, *except veal and pork;* fish; baked, creamed and mashed potatoes; well-made bread; and light cake.

Pastry, fried food, gravies, salad dressing, and all rich articles must be avoided. It is best in most cases to serve five light meals, consisting of small amounts of three or four articles.

**When the sick person is getting better.** The period of recovery is a trying one. Exertion is followed by exhaustion and discouragement. The farm woman is usually obliged to get up too soon. Every effort should be made to keep her quiet as long as possible. In cases of childbirth, even after a normal confinement, she should be in bed at least 10 days, while another week should be given over to "finding her feet" before any work other than the care of the baby is taken up. The loss of time just then will be more than made up by reason of the better health with which she will work when she begins.

**Destroying the disease germs.** During contagious diseases, the nurse, the patient's room, and everything which comes near the patient should be disinfected constantly. At the end of the illness, the room must be fumigated, and the patient herself, as well as any clothes which have been exposed to the contagion, must be disinfected. There is no good accomplished by hanging around the sick room cloths soaked with disinfectants. Germs must be caught and drowned, as it were, in the solutions; they cannot be killed at long distance.

**Chloride of lime.** The discharge of patients, in illnesses where those discharges carry contagion, should be disinfected before they are buried. For this purpose a solution of from one to two quarts of chloride of lime must be poured into the vessels where they are deposited. To make this solution, buy the best quality of chloride of lime, and dis-

The farm woman works in her kitchen three hundred and sixty five days in the year. It should be convenient, therefore, and have a pleasant outlook for the mind to enjoy while the hands are at work

This sort of family coöperation is not so unusual. But how often do we find the farmer helping with the dishes or the house cleaning?

WOMAN'S SPHERE MAY BE THE HOME, THE NURSERY AND THE KITCHEN, BUT MANY A FARM SUCCESS HAS COME THROUGH HER AID AND INFLUENCE OUTSIDE THEIR LIMITS

The best farmer is he who raises a structure of scientific "book knowledge," upon a foundation of practical farm experience

A characteristic of successful farmers is an inquiring mind, a desire to know why things are as they are

THE WAY TO TEACH FARMING IS TO MAKE IT INTERESTING. THIS MEANS THAT THE "WHY" MUST BE EXPLAINED AS WELL AS THE "HOW"

solve it in the proportion of 6 ounces to a gallon of water. This is a poison and must be labeled accordingly and kept in a safe place, apart from medicines and foods, and out of the reach of children.

**Carbolic acid.** A disinfectant for wiping walls, floors, furniture, dustpans and other cleaning utensils is made by adding a 5 per cent solution of carbolic acid to a gallon of water. This, too, is a deadly poison.

**Chlorinated soda.** To wash the nurse's hands and body, and the patient's when recovery takes place, use 1 part of a solution of chlorinated soda to 9 parts of water. This is sold under the name of Labarraque's Solution. Mark it "Poison."

**Disinfecting washable articles.** To disinfect washable articles, prepare enough water to cover them. To this water add 40 per cent formaldehyde solution, in the proportion of 2 tablespoonfuls to each gallon. Stir it well into the water, and allow the clothes to soak for at least half an hour. Then wash them as usual.

## Fumigating a Room After Sickness

This may be done either with formaldehyde or sulphur. The room must be thoroughly sealed by stuffing keyholes and cracks, or pasting over them strips of sealing paper made for the purpose, which may be bought from a drug store or mail-order house. One door must, of course, be left free to open for the exit of the person attending to the work. Open drawers, cupboards, and closets, hang unwashable articles on lines strung across the room, spread out the pages of books. Then set a dish of water boiling on the stove in the room in order to fill the room with steam. Unless the air is damp, fumigation will do no good.

First, find out the size of your room in cubic feet in order to know how much disinfectant to use. Do this by measuring it, and multiplying length, breadth and neight together. This gives its contents in cubic feet. Then, divide the result by 1,000 which will tell you the number of thousand cubic feet. This is called "unit space" in rules for disinfecting.

**Sulphur.** If you are going to use sulphur, you will need 3 pounds of it for every 1,000 cubic feet. Place a tub in the middle of the room. Put in it 2 inches of water. Set two bricks in the bottom and on them an iron or tin pan, or a stone crock with the sulphur in it. Pour over this a spoonful of alcohol or coal oil and light it. Then leave the room and allow the sulphur to burn up. Leave it closed for about three hours. Sulphur candles may be used in just the same manner, but they are more expensive if a sufficient number of them is used to get the result.

**Formaldehyde.** In using formaldehyde, 2 pints of it and 13 ounces of commercial permanganate of potassium are necessary for every 1,000 cubic feet. First put the permanganate of potassium in a large wash bowl or galvanized tub in the middle of the room. Then pour in the formaldehyde and leave the room. No burning is needed in this process. It has also the advantage of not tarnishing or changing the color of fabrics.

## The Medicine Closet

The farmhouse medicine closet does not need to be very large. What is not in it is almost as important as what is. It is of great importance not to keep old medicines which have become stale and therefore lost their value, and not to stock it up with patent medicines.

Some of the remedies necessary to the treatment of illnesses may be taken at any time from the kitchen store room. For instance, we have mustard, white of egg, vinegar, borax, starch, corn starch and rock salt, which have already been mentioned. Bottles and bricks for heating can also be drafted from the kitchen.

The medicine closet should contain, however, a fountain syringe, with some additional rubber tubing, or a rubber catheter, for high injections; a clinical thermometer; 2 medicine droppers; a white flannel cloth for fomentations; some rubber sheeting and oil silk; flaxseed; bran; a pound of cotton waste, or the more expensive absorbent cotton; two packages of surgical gauze; a bundle of soft old cloths which have been thoroughly washed, then sewed up in a clean cloth and baked in the oven. A bottle of hydrogen peroxide and half a pint of pure alcohol will often be useful, but if it is not convenient to have them, strong salt and water, borax and water, and vinegar may be used in their place for cleansing wounds or washing the hands and body after exposure to contagion. Castor oil, calomel, and rhubarb and soda may well have places on the shelves. There should also be antidotes for a few of the common poisons. Special illnesses must, of course, bring special needs, but such a medicine chest will find you prepared to meet most of the accidents and illnesses which occur.

FIG. 208. These boys really own these pigs; and in raising, feeding, caring for, and marketing them, they are going to learn many things that will help to keep them on the farm and interested in it. How many farmers give their sons as good a reason and incentive?

## CHAPTER 13

# The Child on the Farm

"THE child is father to the man" and "the boys and girls of to-day are the men and women of to-morrow" are sayings familiar to all of us. Yet how often do we do all that we might, and should, to enable children to assume successfully the responsibilities they are destined to bear? It is a source of pride for a father when his son follows in his footsteps, takes up his business, and carries on, efficiently and honorably, the activities that have been his life-work. Yet how many farmers make any special effort to arouse real interest in and love for farm work, in the minds and hearts of their sons? How many farmers' wives help their daughters to see farm life as something to look forward to and strive for, instead of an endless cycle of drudgery and privation?

Some do, of course; to them are we indebted for many of the nation's best farms and finest farmers. But on many farms there has yet to be born a complete realization that the child is deserving of careful thought and study as well as of affection, discipline and education; that its importance and value as a farm asset—putting aside any other consideration—are far above those of any crop or flock or herd; that as a comrade and a partner, legally and morally, in the farm's affairs, it has rights and privileges that should not be denied it.

The farm can mean much to the child; the child can mean much to the farm—both the individual farm and the farm that represents the agriculture of the nation. It is the aim of this chapter to tell and show what this relationship can be made, and how to bring about its greatest and most permanent fulfillment.—EDITOR.

# TEACHING CHILDREN TO BE HEALTHY AND GOOD

*By* MRS. HELEN JOHNSON KEYES, *who writes with the knowledge that comes from having provided for, as well as borne and cared for, her children. Moreover, she has observed conditions in many families both on and off the farm; she has noted the instances of wealth and of poverty in true understanding and sympathy between parents and their children; and she has sought and formulated many of the principles upon which can be built strong young minds in strong young bodies, and unbreakable ties of family love and comradeship as well. The training and care a child receives during infancy form the root, stem and branches of its development in after life.*—EDITOR.

CHILDREN are much alike, whether born in the city or in the country. The boy born in the country may not become a farmer; and the girl whose first home is in the city may later choose the country as a place to live in. So there are certain principles which apply to the bringing up of all children, regardless of birthplace. Furthermore, it is not right that we should think of country children as making up a distinct group: they do not. So what we have to say here, while intended first of all for the children of the farm, applies, in the main, to all children, whether of city or of country.

The process of teaching our children to keep themselves healthy, and to control their desires and tempers should begin at birth and continue until these boys and girls become men and women. More and more we are recognizing the connection between the physical habits established in childhood and the moral habits which control later life. Children need to be made to understand that he who breaks Nature's laws must pay the penalty. Some one has said, "God doesn't always pay on Saturday night, but he always pays."

## The Baby

Why not begin right? That is, when mothers really have control over their offspring. It is our best chance. Let us commence on the foundation.

**Care at birth.** After the umbilical cord has been tied, the newborn baby should be warmly wrapped, and then each of his eyes should receive a drop of a 10-per-cent solution of argyrol or a 2-per-cent solution of nitrate of silver. The importance of this treatment needs to be strongly emphasized; for it frequently prevents lifelong blindness, to the danger of which many children are exposed at birth. Later, after the mother has been made comfortable, the baby must be washed clean with sweet oil or vaseline and then sponged off with water and soapsuds at a temperature of 100 degrees. The temperature in the room should register about 72 degrees and, although there must be no drafts, the air ought to be fresh and pure. After dressing, the baby must be made warm in his basket and put in a darkened room which is well ventilated, but without drafts. It is best not to allow a baby to occupy the bed with his mother or with any one else.

FIG. 209. Every child should be taught the value and necessity of cleanliness as soon as old enough to learn anything.

**Bathing.** Until about the fifth day, when the stump of the cord drops off, only sponge baths are possible. After this, the normal child should go into a tub every day, in water registering about 98 degrees Fahrenheit. This temperature may be gradually reduced to 90 at 6 months and to 85 at 1 year, if, after each bath, the baby reacts properly. There is no safer soap than Castile; and 3 times a week the bath should include a very gentle washing of the scalp in soapsuds.

**Feeding the baby.** Food is taken primarily for nourishment, and must be made use of in a manner to promote that purpose. The newborn baby should receive little more than half an ounce of milk at a feeding, or

FIG. 209a. But until then, it is the mother's duty to insure the health and cleanliness of ears, nose, eyes and all the body.

10 minutes at one breast. The work of digestion should be accompanied by complete rest. Doctors vary in the length of the rest interval which they recommend, but let us take for granted that it is to be 3 hours between the beginning of one nursing and the beginning of the next. Then we shall have for a convenient daily feeding-schedule, from the third day to the fourth month, the following: 6 A.M., 9 A.M., 12 M., 3 P.M., 6 P.M., 9 P.M., 2 A.M.

After a baby is 4 months old, the 2-o'clock morning feeding may be omitted, and both baby and mother will profit from the unbroken night for sleeping. A child should be awakened for his food. In a little while, he will rouse himself regularly at the end of the appointed time. When the nursing is over, he should be laid very quietly on his back or his right side and encouraged to sleep till the next period. If he is clean, dry, and warm (but not too warm), he will quickly learn to do this; and, if it is evident that he is comfortable, no attention need be paid to his crying while he is learning this lesson.

During the first 24 hours after birth a baby should have no food. Boiled water cooled to body temperature may be given him several times, either from a spoon or from a thoroughly clean nursing bottle with a thoroughly clean nipple. The second day he should be put to the breast every 4 hours and once in the night. The third day the regular interval should be established and followed by the clock. The length of time allowed for a nursing may be gradually extended during the first month from 10 to 20 minutes; at no age is more than 20 minutes advisable. In the case of a bottle-fed baby, an easily remembered general rule is that he may receive one more ounce at a feeding than the number of months he is old. Fifteen or 20 minutes should be allowed him to take this amount, which can be arranged for by regulating the size of the 2 little holes in the nipple, and by removing the bottle for a moment, if the contents are disappearing too rapidly. See that the bottle is held in such a way that the neck is always filled with milk; otherwise, the baby will suck in a certain amount of air, which is likely to produce colic.

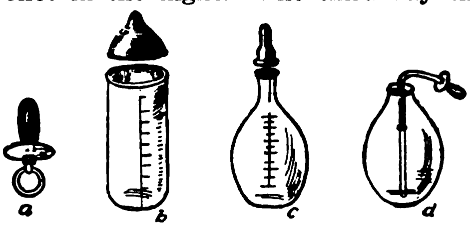



FIG. 210. Some things to avoid: *a*, the pacifier, which is often unclean, and usually productive of poor health and bad habits; *c* and *d* are both unsanitary nursing bottles, *d* being much the worse; *b* is the right type to use.

**Weaning.** Every healthy mother should make a great effort to nurse her baby, because no other food is exactly what the infant's stomach requires. No food has been found which produces the body-building materials in the same proportions, and the breast-fed child has far greater power than the bottle-fed to fight off illness. There are, however, certain diseases which may render a mother's milk entirely unfit; and in the case of a second pregnancy, weaning should take place at once.

No child should be nursed more than one year, and in most cases, it is necessary to introduce artificial feeding at about the ninth month. A doctor should be consulted for the correct mixing or weakening—called modification—of cow's milk. The weaning, unless the necessity for it is hastened by the mother's illness, should be made gradually, beginning with one bottle of cow's milk a day. Cool weather is better than warm for the change, but the important thing is to be sure that the milk is kept cold and fresh.

**Making the milk safe for baby.** If you are not absolutely sure of the health of the cows and of the sanitary manner in which they are kept and milked, pasteurize the milk for baby each day. That is, heat the milk so as to kill dangerous germs, but without raising the temperature to the boiling point. The best way to do this is to mix or weaken the milk as the doctor has directed for the number of feedings which baby has in the 24 hours.

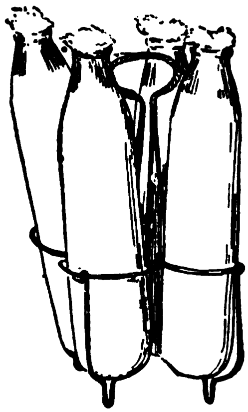
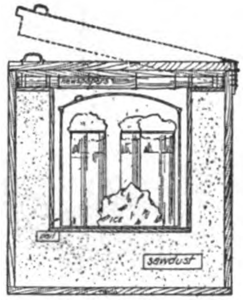


FIG. 211. Nursing bottles prepared, stoppered with cotton plugs, and in a holder ready for the sterilizer or the ice box.

Pour this supply into as many bottles as there are feedings. Cork the bottles with absorbent cotton, and stand them in a rack, which may be made by topping a kettle with lacings of wire so spaced as to support the bottles. Then stand this bottle-filled rack on a pie plate turned upside down and having holes punched in the bottom, first having placed the plate in a pan of water. Place the kettle on the fire and a thermometer in the water, and when the latter registers 155 degrees Fahrenheit, take the kettle from the fire, cover it and the bottles with a blanket, and let them stand so for 45 minutes. Then remove the bottles, immerse them in lukewarm water, then in colder and colder water as the glass will bear it, and finally set them in the coldest place you have, best of all on ice. Rapid cooling is a necessary part of pasteurization. There are pasteurizers on the market which for ease and accuracy of work are to be preferred to any homemade device.

When the milk is fed to the baby, its warmth must be such that a drop falling on the back of the hand feels just tepid. This is done by placing the filled bottle in a dish of water on the stove for a few minutes. Let the child take what he desires in 15 or 20 minutes, and throw away what he leaves. Milk which is kept after warming, develops a dangerous number of microörganisms, or germs, and is poison to the stomach. No matter how little the baby has taken, let him go without more till the next regular feeding time. This is very important. Boiled water, cooled to tepid, should be given occasionally each day, between meals.

**Care of the bottles.** When all the bottles are empty, rinse them in soapsuds and then in clear water, and boil them for 10 minutes. Add a teaspoonful of borax or of boracic acid to the water, and allow them to remain in it until you are ready to fill them for the new day. The nipples, of which there should be as many as there are bottles and feedings, must be rinsed inside and out and boiled for 10 minutes, too. They may then be kept dry in a covered dish. In putting a nipple on a bottle, do not touch the part which the baby sucks, but stretch the lower part of the nipple over the neck of the bottle.




U. S. PUBLIC HEALTH SERVICE

FIG. 212. Homemade ice box on the fireless cooker principle, in which a day's supply of prepared nursing bottles can be kept. (U. S. Public Health Service.)

**Feeding after infancy.** At 1 year a normal child is ready for whole milk taken from a cup. To it may be added starch-bearing foods thoroughly cooked and strained until about like a thin jelly, 2 ounces of one of these to 8 of milk. There should be 5 feedings a day. At the mid-day meal, beef juice may precede the milk, beginning with 1 teaspoonful and increasing to 2 ounces. This is made by chopping finely 1 pound of lean, uncooked steak, and standing it in 8 ounces of water in a covered dish from 6 to 8 hours in a cool place. The meat is then put in a piece of coarse muslin and twisted till the juice flows. This will yield about 3 ounces. Salt or celery salt may be added, but no other seasoning. Meat presses, also, are used for making beef juice, in which case the steak is slightly broiled and then put in the press. The juice should always be given at a temperature under 100 degrees, else it will be indigestible. If the baby dislikes the taste, the juice may be added to the milk, when the flavor will hardly be detected. Twice a week a soft-boiled egg, with dried bread crumbs or unsweetened cracker crumbs, may be substituted. Orange or prune juice, a tablespoonful once a day, should be begun at 4 months and continued.

At 18 months, unstrained cereals, thoroughly cooked, may be given with milk or cream, but are best without sugar. At mid-day, 1 teaspoonful of raw, scraped beef is good. This may be alternated with chicken or mutton broth from which all grease has been removed. Good bread with a little butter may be added to each meal; and, instead of juices, a tablespoonful of the pulp of stewed apples, peaches, or prunes may be used once a day. Three meals a day, with a glass of milk between each, are enough.

Milk should be the basis of the diet at least until the seventh year. A child should drink

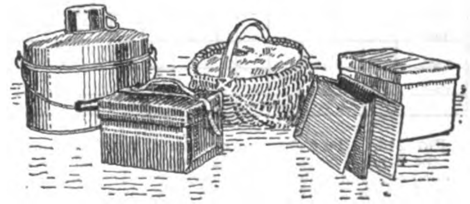


FIG. 213. Desirable types of lunch boxes for the child to take to school or on trips away from home

FIG. 214. Frequent, regular weighing is a good way to keep track of the baby's progress and growth.

a quart a day. Baked or mashed potatoes and soft-boiled, poached, or scrambled eggs, as well as certain green vegetables, especially peas and stringed beans, may be given frequently after the second year. Chicken, beef, or lamb, when broiled or roasted, may be cut very fine—minced—and a tablespoonful given 3 times a week in the middle of the day after the second year. The amount may, of course, be increased, and the cuttings become less fine as the child grows up. The evening meal should not consist of anything heavier than toast and cereal. Loaded stomachs mean restless sleep.

The following articles should be prohibited until the seventh year at least:

Corned beef, dried beef, veal, pork, ham, game, kidney, liver, sausage, and stuffing; fried foods of all kinds; cucumbers, onions, celery, radishes, beets, eggplant, corn, pineapple, and salads; cheese, rich cake, pastry, preserves, jams, and candies; tea and coffee and all alcoholic drinks.

**Weight and development of the baby.** Correct scales are important, because they tell whether or not the baby is receiving the right nourishment. A weekly weighing should take place for the first year. There is a loss of about 10 ounces during the first 3 days of life, the birth weight being regained about the tenth day in the case of breast-fed babies, but not for 3 or 4 weeks in the case of those who are bottle-fed. After this, 6 ounces a week is the least gain which a healthy child should make during the first 6 months. After an illness, very light feeding may be necessary, and weight is not to be considered, but only the recovery of the digestive apparatus. During the second 6 months, a gain of 4 ounces a week is satisfactory. At the end of the year, a child should weigh about 3 times as much as at birth.


FIG. 215. Chart showing number of registered deaths in the United States in 1912 from intestinal diseases among children under two years of age. The total is 42,482 of which 24,298 occurred in July, August and September! No wonder the second summer is "dreaded"; yet the fault lies mostly with the parents who fail to give their children the right care.

Average babies weigh from 6 to 9 pounds at birth, and are about 21 inches long. They can see only patches of light and darkness. Not until the end of the third month do their eye muscles act harmoniously, so that the crossing of eyes before this age need not cause anxiety. Eyesight remains somewhat defective up to the eighth year, which fact we should remember when we begin to educate our children. The new-born baby is deaf for 24 hours, after which his hearing becomes very acute, and he should be protected against loud noises. The teeth are present in the gums at birth; and they grow steadily until, between the fourth and ninth months, the 2 lower incisors usually appear. The process of cutting the first set of teeth, 20 in number, is complete at about 2½ years of age. There should be no illness connected with this process. Never neglect any indisposition which occurs at this time, saying, "It is only a tooth." Many, many children die from neglect, because what is really a symptom requiring medical care is put aside as due to the teeth. Babies should be just as well during teething as they are at any other time; and they will be, if they are properly fed, and their ailments receive prompt attention.

**A healthy second summer.** The dreaded "second summer" has become a season of illness only because at that time we often begin to overfeed children and to give them starches and other foods suited to grown people, but not suited to little stomachs.

**Clothing.** During the first month, a baby wears around his abdomen a flannel binder secured with small safety pins. These pins should not be directly over the spine nor over the navel. Half a yard of 27-inch flannel will make the 3 binders which are necessary. At the age of about a month, the binder is exchanged for a knitted band with shoulder straps, worn, like the binder, under a long-sleeved shirt. A mixture of cotton and wool is best for these two garments, for the flannel petticoat, and for stockings. Stockings are unnecessary for the infant in long clothes, for usually they are either wet or are kicked off and dangling from a pin. The feet can be kept warm by blankets.

**Learning to sit up.** Season and climate permitting, long dresses may be changed to short ones at about 6 months of age, when the legs need freedom for exercise. Little flannel jackets become useful at this time; for, when the baby is about 8 months old, he learns to raise

himself into a sitting position, and remains there. Until then, he should be encouraged to lie as flat as he will, without even a pillow under him, and firm support should be given to his spine and head when he is carried. Serious curvatures often result from the neglect of this support and from the effort to hasten the sitting-up period.

**Standing and walking.** Between the third and fourth months, a baby begins to use his hands intelligently, learning to grasp the objects of his desires. From the ninth to the fourteenth month, he is busy learning the use of his feet. At 14 months, he is usually able to walk alone. All contrivances to hurry this accomplishment, such as baby tenders or baby jumpers, are to be avoided. A child should stand and walk exactly when he is able to, without being either urged on or held back.

**Talking.** At the beginning of the second year, a child utters a few words, and invents a name for his mother. By the end of the year, he is forming sentences, still somewhat incomplete, but making sense. After this, improvement is rapid.

**Fresh air.** Nothing has been said about fresh air, which is a matter only second in importance to good nourishment. The age at which a baby may go out of doors depends, of course, on climate and season. In a temperate climate, during fall or spring, this may safely occur in the second or third week. Soon afterward, the habit of sleeping out of doors all day during fine weather should be established. The carriage is the best bed for this purpose if it has a hood. The greatest care should be taken to protect the baby's eyes from the sun; and the hood should be reversible, so that it can be shifted quickly for this purpose, as the light changes. Every device for keeping the baby and the child out of the house and in the fresh air in good weather should be used.

## When the Child is no Longer a Baby

**School life.** At 6 years of age, many a child enters school. The writer believes this to be 2 years too soon. His eyes are not ready for close work; his body rebels against restraint; and his mind is incapable of absorbing the work given him. He is likely to form habits of dawdling and idleness in the schoolroom, because there is little that he can do. Happily, though, modern methods of teaching, combining work and play, are bringing about great improvements.

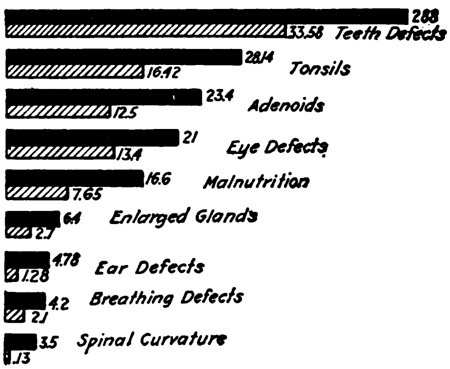



FIG. 216. Comparative per cents of physical defects in country children (*solid black bar*) and city children (*shaded bar*) based on more than 500,000 examinations. The figures show the number of children affected per hundred. This is the result, partly, of insufficient medical inspection in rural schools and districts; but partly too, of the ignorance and negligence of country mothers. (From the "Progressive Farmer.")

If it is possible, educate your child by very light home work at this age, and give him opportunity for free play. Answer his questions carefully; cultivate his powers of seeing things and his interest in nature; and, if he seems to want to learn, teach him how to spell and read a few words, to tell time, to count, and to make change. If he can begin school with so much knowledge, great will be his gain.

**Physical defects.** When school life begins, the child should be carefully and lovingly watched. You may be suddenly forced to fear that your little girl or boy is stupid. Do not be too quick to believe school reports. First make sure that your child sees correctly; perhaps his slowness in reading is due to the fact that he cannot see what is written. A pair of glasses has frequently changed a dunce into a creditable pupil. Be sure that the child is not deaf; perhaps his failure to recite is owing to his not hearing the question. Many children who hear poorly are afflicted with adenoid growths which stop up their noses and spread to the ears. Sufferers from adenoids, even when not deaf, have low vitality—are weak—because of disturbed sleep and of loss

Fig. 217. The play spirit is one of the blessings of childhood. It should be fostered, not destroyed. Too many farm boys and girls are robbed of it by drudgery and lack of sympathy both at home and in school

of strength by the mere effort of breathing, and because of the lack of oxygen in the lungs. Children having adenoids may also have enlarged tonsils, which produce an almost chronic state of sore throat during the winter. A simple operation for the removal of these growths will be followed by marked increase in stature and a brightening and clearing of the whole mental life. Be sure, too, that the teeth are sound. Who could study with a vibrating tooth? Decayed teeth, moreover, are a cause of indigestion and general run-down condition. This is due to the poisons which pass from them to the stomach, and which are taken up by the general circulation and passed through the system. Teeth, as soon as they come in, should be brushed twice a day. By the time a child is 4 years old, he should be trained to do this regularly and thoroughly for himself, and to realize the filthiness of decaying matter in the mouth. A sound first set does much to insure the excellence of the second set; for only when the first teeth are clean do the roots come out as they should, leaving free space for the roots of the second set. A good diet and active toothbrushes will usually insure good teeth, but, when these means are not sufficient, a good dentist should be visited.

There are serious nervous troubles whose first symptoms are peevishness, lack of attention, awkwardness, and strange attacks of temper, weeping, or mischief. Before being too stern with the small offenders, consult a doctor.

Fig. 218. The Boy Scout movement is an invaluable means of turning the vigor of youth into useful, manly channels.

**The backward child.** The mother of the apparently backward child should recall that many a man and woman who has become distinguished in later life was considered dull in school. After making sure that the child's slowness is not due to some physical defect which should receive medical care, the next thing to do is to find something which interests him and which he can do well. Often, such training in one direction not only produces efficiency there, but also leads at last to an understanding of other things. Schools are patterned to suit a certain type of child, so when a child who is different is to be taught, the teachers are not always quick to understand him. Consequently, many a bright child fails to make good progress in school. There is always a way to reach and teach these odd youngsters, and mother and teacher ought to put their heads together to find it.

**Stages of moral development.** It is a help in bringing up boys and girls to realize that

they pass through certain stages of development which cannot be entirely controlled or very much shortened, however hard we try. For instance, until a child is 10 or 12 years old, he is a loud spokesman for his own rights, and uncomfortably indifferent to other people's pleasure. This is a period of self-assertion, and, frequently, of quarreling. While we must lead our children at this age to restrain their selfishness and to be thoughtful of others, we should, nevertheless, be patient and merciful with them; for every child has to learn the meaning of family and community life. Sharing in the labor of farm and home during early years, is one of the best ways to teach children to work with others.

**The poet's age.** Children see and hear many wonderful things in childhood's wonderful world. It would hardly be too much to say that every child is a poet for at least a little while. This being so, feed the imaginations of children. Their lives will always be richer and finer if you do. Far too soon we become prosy and matter-of-fact. Let children carry forward a few memories, at least, of companionship with fairies and make-believe folk. They need, too, abundant time for free play with other children whom you know to be wholesome and clean.

FIG. 219. The garden is a splendid place for children to develop in. School and community gardens are especially good since they combine work with pleasure and companionship.

**The gang spirit.** At 10 or 12 years of age, boys and girls become sociable. They develop the club, camp, and gang spirit. Let your home be a meeting place for them with their friends. Know the children whom your sons and daughters have chosen, and help them to choose rightly. Encourage games, indoors and out of doors. Let the children have little parties. Join with them in camps and picnics. The Boy Scouts and Camp Fire Girls movements have been built upon the gang instinct, and have made it valuable to the children and of real service to the community. It is always better to turn the tastes and desires of children to good account than to suppress them. They are the finest levers we have in the educational process. When, for instance, this gang spirit is let run wild or is not guided, it may lead to crime. If, on the other hand, we show the child how to express his natural instincts in serviceable ways, they become uplifting forces. Sympathy and understanding are the great needs of every parent.

**Adolescence.** Do not worry greatly over the disagreeable traits of character which your children will surely develop at adolescence, the period when youth replaces childhood. There are great changes going on in their bodies and minds. Balance is upset. Later, though, it will be reëstablished. Give the children plenty of nourishing food; see that they sleep 10 hours a day—out of doors, when possible—and that they are not overworked, yet have duties which will keep alive their sense of self-respect and usefulness in the family plan. If they are moodish, careless, impudent, even bad as can be, remember that they are struggling to find themselves, to get their bearings on new roads. Then it is that they need the best of physical surroundings and lots of patient love—love which asks few questions and demands little in return, but which understands and helps.

**Moral forces.** If you have been wise, a perfect confidence has existed between you and your children from the beginning. You and they have been

honest together, asking and answering questions openly and with a reverence for truth. This will help at the trying period of adolescence. It will draw them to you.

Your children will have learned, long before this, the need of self-control in food and the reasons for system, order, and cleanliness. They will, also, have many interests in nature and in books, and these will protect and satisfy them in the trying changes from early childhood to maturity.

**Work as well as play.** As the healthy child grows older, he is not satisfied to play all the time, but wants to have a part in doing things—in work, real or make-believe. If these activities are rightly directed, they will prove of great benefit. It is a good plan to give the little lad on the farm a tiny garden of his own. If he is too young to plant it, he should be helped; but all the work should never be done for him. When the vegetables are ready to gather, the work should be looked after by the little owner of the garden; and with what pride will he proceed! For children, we know of nothing better than garden making. In it there is the pleasure of planning and planting, of watching the vegetables or flowers grow, and of enjoying the fruits of one's own labor. Children so engaged are doing more than keeping out of mischief. In cultivating their own flower gardens they are also cultivating a love for the beautiful. Then, too, the child who is allowed to have his or her own flowers very soon learns something of the meaning of property rights, and will be slow to pluck blossoms from other gardens.

FIG. 220. Ownership breeds self-reliance, pride, industry and ambition. Let the boy or girl have a calf, a pig, a flock of chickens—something to care for, work for and to enjoy the profits of.

Children like to do things for themselves, and always they are doing things, good or bad. Children who scar the furniture with their hatchets or saws, do so because they have never been taught to make better use of these tools, to build instead of destroy.

In springtime, when the sap is up and the bark works best, it is worth while for the father to take time to show his little son how to use his knife in making a whistle. The boy, too, should be taught how to make a popgun from the roadside alder. The building of birdhouses offers still larger opportunities for lessons in carpenter work and character building. In providing a home for the birds, the boy learns the use of tools, is made more familiar with the habits of birds, and comes to think more of them. At the same time, too, he will be made to love his own home all the more. The girl who, while working with her mother in canning and preserving, is allowed to provide small glasses and jars of jellies and preserves for her school lunch, will prove a willing worker. All these little partnerships, whether of work or of play, make for clearer understandings and broader sympathies between parent and child. There is also learned the valuable lesson that there is more pleasure in making many of the things we need than in paying somebody else. The value of time also comes to be appreciated.

**Something for his very own.** Boys and girls, as they grow older, want to own things that are "worth money," as they so frequently express it. This

desire should be encouraged. A little property for his "very own" has anchored more than one boy to the old home. It is a fine thing to give the boy a pig or a calf or to let the girl have a definite interest in the poultry yard. Always, though, they must be made to understand that ownership carries with it certain duties. The stock or poultry must be looked after. Just here it may be suggested that it is a mistake to give the children nothing better than scrub calves, the runt pigs, or the poorest birds in the poultry yard. It is, of course, all right to let them have these, but they should also have some of the best that the farm affords. Remember, too, when the pig has become a big hog and when the calf has grown to be a cow, that these larger animals still belong to the youthful caretakers, and that the mere act of growing up does not change ownership. If it is desirable to dispose of the larger animals, buy them from the children or give full value in something else. Educate children in honesty and "the square deal." Do not deceive. Never even so much as do what, to the child, may appear doubtful.

**As the twig is bent.** Because you have been wise, your children will have formed the habit of honest work, and so they will want to be helpful. They will regard themselves as responsible and necessary members of the family. This will give them a just pride and a sense of power and dignity, against which they will be slow to offend by bad conduct.

It is all one logical, continuous story, from the first time that your babies cried for a feeding they should not have, and you saved them from illness by training them to order and self-control, until at last you survey your mature children, and know that they are good. It is in the power of almost every mother and father so to fulfill their responsibilities as parents that their children "eschew evil and cleave to that which is good."

## WHAT THE FARM AND FARM HOME SHOULD DO FOR THE CHILD

*By* ELLA FRANCES LYNCH, *of Bryn Mawr, Pa., founder of the National League of Teacher-Mothers; a woman who can see into the future and visualize the needs of the young and the means whereby they can be supplied. The farm is often spoken of as "the best place in the world for children to grow up on." Sometimes it is; often it is not. Mrs. Lynch tells how to make it so.*—EDITOR.

NOWHERE can the foundations of that education which makes for lasting benefit to humanity and to true happiness for the individual be better laid than on the farm. Here the old-fashioned virtues of obedience, orderliness, patience, promptness, cleanliness, self-control and self-reliance are essentials to success; and the child should, and will, be led to value them, even before his or her schooldays begin. Indeed, on the farm, helpful habits are formed of necessity and almost unconsciously.

**The farm is a wonderful kindergarten.** The kindergarten is regarded by many mothers as the first step in education; and so it is. The word

FIG. 221. Let the children help. Give them an interest in the work and success of the farm. Treat them as partners, not as hired help.

FIG. 222. As the school has widened its field to include the physical as well as the mental development of its pupils, so the farm should be made to broaden children's minds and characters as well as to strengthen their muscles.

means "children's garden." The most wonderful children's garden in the world is the farm kindergarten—the house, the yard, the barn, and the fields. The family, the household pets, and the livestock furnish invaluable aids and equipment.

We are too apt to think of a kindergarten as a large room with a white circle painted on the floor, around which the children place their little chairs for the morning talk. Because of lack of space and opportunity, this is about the best our schools can furnish. But in many European cities, where they know that the best ordinary kindergarten is only a poor substitute for the farm home, the kindergarten is now a large farm, where the children go in the morning for the day. Here they learn to milk a cow, to care for milk, to churn cream, to plant and tend a little garden, to put up preserves, and in various ways to imitate the work of grown-ups. Can we not have this, each in his own farm home?

**Let the children help.** Begin by teaching the children to help themselves; to put on stockings and shoes; to dress themselves; to put on hats and coats, even if they have to be adjusted later. Also, give them little tasks about the house, such as using the tiny broom, the brush, and the dustcloth, and let them bring things for the mother. Out of doors they may help in pulling up weeds, gathering chips, in picking vegetables, and so forth. Let the little 5-year-old pick a cupful of berries or currants, weed a tiny garden bed, marking off a space of perhaps a square foot; bring food and water to the old hen and chickens; gather a pan of apples or potatoes; dust the chairs or the sewing-machine, and run little errands for the mother. All of these tasks help in sense training. In drying the dishes, for example, the child learns about china, silver, glassware, heat and cold; and in handling fruits and vegetables he or she notices the difference in the feeling of each.

The habits of promptness and regularity are soon formed. The daily chores of the household and the farm must be done every day, day after day, and on time. "I forgot" does not fill the woodbox. The blackened chimneys and empty reservoirs of the house lamps tell their own tale. If the pigs are not fed, they promptly tell the world of it. Thus the very routine of the farm and farm home teaches the child to be prompt and regular.

Farming is the one industry in which it is right and proper that children should assist from their early years. Indeed, the child carefully trained in the farm home gets a fair education without much schooling. The making of chicken coops, sleds, wagons, and playhouses, and the repairing of fences, all give skill in the use of tools, and this skill is helpful in after life. Children thus learn how to accomplish tasks in the easiest way, with the fewest motions, and in the shortest time.

Let the child begin early to make things. He loves to build houses, and is satisfied with a few sticks laid upon the ground. Let him build ladders, anything he likes, as crudely as he may.

**Training the whole child.** Well-directed sense training during the first 10 years of life will teach the child to see and hear attentively and correctly, to discern. and to judge. This means the training of ear and eye, and the culti-

vation of the senses of taste and smell and touch, to judge time, dimensions, weight, temperature, color, etc. This sense training must begin before the sensitive organs are dulled by neglect or misuse. The lack of it is responsible for much of the so-called dullness in school.

**The wonder world.** The little child sits on the doorstep, watching the swallow intent upon flycatching or nest building. No teacher is there to break the spell, because the period is up and the restless class wants to do something else. The child sits by the brook, and floats his chips down. How he watches and wonders, his mind struggling to awaken and ask the questions he does not yet know how to ask. Leave him alone. His mind is expanding as it could not do in the most up-to-date schoolroom. When he asks you where the brook goes, tell him. Answer his questions, if you can. This is the greatest rule of teaching. The child's answers to your questions are not a safe standard for measuring what he knows, but the questions he asks you are the unerring indicator of what he is ready to be taught.

**As the child grows older.** From kindergarten to the age of 10 is an important period in the life of the child. The aim should be to form the character by developing correct habits, creating the habit of work, and by training the senses, so as to increase the powers of observation. Try to open the eyes of the child to the wonders of the natural world about us.

There must be no seemingly endless tasks, and no complicated lessons at this age. A single direction should be sufficient for any task within the small child's reach; but, once given, the task must be done promptly, completely, exactly as you directed it to be done.

**Using eyes and ears.** Teach the child to use his eyes. How many legs has the fly, the spider? Do you know a moth from a butterfly, or an angleworm from a measuring worm, a cutworm, or a centipede? Do you know a frog from a toad, or frogs' eggs from toads' eggs? Which creatures are warm-blooded and which cold-blooded? These are some of the questions the child may be taught to answer.

Welcome the birds as they arrive. Talk to the children about the birds' journeyings, their nest building, their choice of homes. Watch for the birds that get mud to plaster their houses, and those that want hair and feathers for lining. Coax the wrens to build in the back porch.

Tell the children about the great tree that grows from a little seed. Show them seedlings. Tell them Æsop's fables of "The Ants and the Grasshopper," "The Hare and the Tortoise," and others. The lessons given in these stories are more effective now than during the kindergarten period.

Say to the child: "Stand with your right hand to the east and your left hand to the west. You are then facing the north. The south is behind you." This will be remembered and applied many times in after life.

**Nature a great teacher.** Train the child to lead an out-door life. In early times, people lived out doors, and became far more observant of their surroundings. We owe the beginnings of our great sciences to out-door folk who had little knowledge of books. Mathematics, which makes all sciences possible, came to us in this way. Astronomy was studied by the simple shepherds of Chaldea, lying wakeful on the hillsides. They traced the principal star groups and named them, though they had nothing to aid their study but the naked eye and the rich fancy born of life in the open field.

Teach the child to look at the heavens, noting the changes, both day and night. Begin by pointing out a single star and have him watch for its rising evening after evening. It is a great moment for the 9-year-old when he learns that the stars, like our sun, rise and set. Point out to him the Dipper, and

study with him, if possible, some simple account of the heavens, with illustrations, that will help him to know the principal stars. Teach the child to love everything in nature, however humble, abundant, or commonplace.

**The value of home training.** A young woman entered a state normal school a few years ago, and surprised her teachers and fellow students by her excellent progress along every line of study. She was permitted to complete the usual 4-year course in 2 years, although she had attended high school but 10 weeks. She is to-day a successful magazine writer and lecturer. What was her early history? She grew up on a farm and did her share of work, indoors and out of doors. Fortunately, the home was supplied with good books, so that the curiosity aroused in her by looking at the stars, the flowers, and all living nature could be satisfied in the long winter evenings by unaided study. Until she entered the normal school, however, she had never seen a railroad train, a steamboat, an electric light. Yet, far from holding her back, her home surroundings had helped her mind to develop slowly and naturally, until with maturity came unusual strength.

**The Country Boy's Creed**

*I BELIEVE that the country which God made is more beautiful than the city which man made; the life out of doors and in touch with the earth is the natural life of man. I believe that work is work wherever I find it, but that work with Nature is more inspiring than work with the most intricate machinery. I believe that the dignity of labor depends not on what you do, but on how you do it; that opportunity comes to a boy on the farm as often as to a boy in the city, that life is larger and freer and happier on the farm than in the town, that my success depends not upon my location, but upon myself—not upon my dreams, but upon what I actually do; not upon luck, but upon pluck. I believe in working when you work, and in playing when you play, and in giving and demanding a square deal in every act of life.*

—EDWIN OSGOOD GROVER.

# GIVING THE CHILD ITS SHARE

*By* MRS. HELEN JOHNSON KEYES. *The world is being tested by the fires of war and adversity that the powers of evil may finally and effectively be conquered by right and justice. The least that we can do is, each within his or her own little sphere, to uphold and carry out those principles of right and justice in our relations with those around us. And how better can we begin than by giving the children on our farms their full share of life and all that it has to offer?*—EDITOR.

FIG. 223. Just because it is good fun, testing seed corn by the rag-doll method is no less valuable than any other. Children are never lazy when they are interested; the aim should be, therefore, to keep them interested in the farm and its work.

IT is from the partnership of the home that children should receive their just share of training for life.

The American farm offers bountiful opportunities for the rights of young people, for here it is possible for all the members of the family to work together. Unfortunately, however, these opportunities are not always understood and used. We have not learned yet just what the needs and rights of young people are. We forget that they need a great deal of play, rest, companionship and freedom mixed with their work. We even forget that they need us; for do we not silence them when

they express their opinions? Are we not careless about answering their questions? Do we not put them to work with more thought in our minds of the work than of the child who is to do it? This must end, for the best crop of the farm is the children.

The traits of character which our boys and girls need most when they go out into the world are: (1) industry; (2) honesty; (3) affection; (4) the spirit of helpfulness, and (5) the ability for leadership. A training which shall make them strong in these qualities is their just share. But how shall we go about giving it them? Let us see.

**Industry.** It is easy to make a child work hard, but that is altogether different from training him to be industrious. So long as he works only because we compel him to do so, when our authority over him ceases, he will stop working. In order to make a child industrious, he must see the advantage of industry: he must have a share in the comforts and benefits which come from a task well done.

We have all noticed how eagerly the young child attempts his new task and how, with constant, dull repetition of the labor, his interest wears away. He may continue to be a worker, but probably he is not developing the love of being industrious. Can we not put back into what he is doing something of the old excitement and interest?

The kind of interest which almost always may be put into work is that of invention and improvement. There is usually some better way of doing a thing than the one in which it is performed day after day. Why not suggest to the youngsters that we and they constantly watch for methods to save time and strength while yet improving results? We should talk this over with them, because they are our partners. The child who gets a box and stands on it, in order to reach the sink more easily, puts into dish-washing the excitement of an invention; the boy who learns how to fatten his hogs better than his neighbors will not mind taking care of them; the girl who learns to cut her cloth so economically that the amount of material which she once required for a dress alone will now give her a shirt waist, also, will love to make her own clothes. Moreover, with the connections between work and reward firmly established in their minds, the habit of industry will become fixed.

**Balancing work with rest.** There is another side to the training of children for a life of industry. We all hate what we get too much of—even kindness and candy! Children certainly will hate work, if it is not relieved by a large amount of rest. Boys or girls who go to school already tired from toil in the early morning hours, following a night of too little sleep for growing bodies, will probably hate work and decide to shirk it by and by. *We may have forced them to work, but we shall not have trained them to be industrious.*

**Honesty.** We are not giving our children their just share unless we train them to be honest. This we may do by being honest with them ourselves. They learn by copying us; and if we answer their questions with untruths, they will answer us and other people in the same way, no matter how much we may talk about the sin of lying. If we do not know the answer to their question, we should say so, and, if possible, find out about the matter or tell them where they can do so. If we believe that the answer is not suitable for them to receive, we should say so. But let us remember that young people are right in wishing to understand life, and that we, as their closest partners, should be their instructors.

**Contracts.** Honesty consists of something more than telling the truth. It includes acting fairly and squarely in all the relations of life. Sometimes a

child is given a pig, or a calf, or some land to call his own, to take care of, and to receive the profits from, as he supposes. He devotes time and interest to it and produces something of marketable value. What sometimes happens? His property is taken from him, and the proceeds of the sale are pocketed by the very person who gave, or pretended to give, it to him. This is dishonest. The child knows that it is dishonest and knows, also, that partnership on this basis is impossible. Such treatment is not giving him his share. It cheats him not only of his property, but also of his training in honesty and respect for contracts. It inflicts a permanent injury; for he will think: "Oh, it is necessary only to talk about honesty, then one can go ahead and cheat and break contracts the way mother and father do." And he will decide, too, that there is no such thing as team work, that it is a case of every man for himself.

**The Country Girl's Creed**

*I AM glad I live in the country. I love its beauty and its spirit. I rejoice in the things I can do as a country girl for my home and my neighborhood. I believe I can share in the beauty around me—in the fragrance of the orchards in spring, in the bending wheat at harvest time, in the morning song of birds, and in the glow of the sunset on the far horizon. I want to express this beauty in my own life as naturally and happily as the wild rose blooms by the roadside.*

*I believe I can have a part in the courageous spirit of the country. This spirit has entered into the brook in our pasture. The stones placed in its way call forth its strength and add to its strength a song. It dwells in the tender plants as they burst the seed-cases that imprison them and push through the dark earth to the light. It sounds in the nesting notes of the meadow-lark. With this courageous spirit I too can face the hard things of life with gladness.*

*I believe there is much I can do in my country home. Through studying the best way to do my every-day work I can find joy in common tasks done well. Through loving comradeship I can help bring into my home the happiness and peace that are always so near us in God's out-of-door world. Through such a home I can help make real to all who pass that way their highest ideal of country life.*

*I believe my love and loyalty for my country home should reach out in service to that larger home that we call our neighborhood. I would join with the people who live there in true friendliness. I would whole-heartedly give my best to further all that is being done for a better community. I would have all that I think and say and do help to unite country people near and far in that great Kingdom of Love for Neighbors which the Master came to establish—the Master who knew and cared for country ways and country folks.*

—JESSIE FIELD.

**Affection.** We love what is lovable. That is a simple truth, but it is often forgotten. We have an impression that we love what we ought to love; that children particularly, unless they are very wicked, will love all their near relatives and their home, because that is a nice and proper thing to do. But we are mistaken. They will love them only if they are lovable—that is, cheerful, fair, and kind. It is a hard and brutal fact, one which it would be more pleasant not to have to admit, that some children never love their fathers and mothers much. On the other hand, it is natural to every normal boy and girl to love them very dearly, and when he does not it is usually because his affection has been repulsed. The parent does not intentionally repulse it, but he neglects those claims to respect and consideration which are the children's share. He forgets, perhaps, that they need friends of their own ages and that they wish to bring them into the home; he forgets that boys and girls require a little spending money for the use of which they do not have to account carefully. He does not ask them what color they think the barn should be painted, or what their ideas are as to fencing. Unless boys and

Health, strength and a realization of the necessity and importance of work are invaluable riches that the farm holds out to children

Nowhere better than on the farm can the wonders and beauties and mysteries of life be encountered and explained

THERE IS NO BETTER PLACE WHEREON TO RAISE CHILDREN THAN THE FARM; IT SHOULD BE MAINTAINED, THEREFORE, SO AS TO HOLD THEM AND THEIR INTERESTS THERE


Boys and girls should receive a share of the profits in proportion to the part they played in making them, as a just return for this sort of spirit, regardless of its result

The farm home can provide a more varied, more generous diet more cheaply than any other household. A practical knowledge of how to make it do so is invaluable

THE FARM IS THE HOME AND SUPPORT OF ALL WHO LIVE ON IT; WHY NOT GIVE EACH, DOWN TO THE VERY YOUNGEST, HIS OR HER SHARE IN ITS DEVELOPMENT AND OPERATION?

girls are taken into partnership in the life and decisions of the farm home, their hearts will wander far from it.

And what a serious loss that is! It would be better to send a child on a journey half-clothed than to send him out into life without the love of home in his heart. If he does not learn the habit of affection on the farm, he will scarcely know how to form the friendships and partnerships which make later life strong, beautiful, and successful. He will have been robbed of what was his share in youth.

**Parties.** Let us show the boys and girls that the farmhouse is theirs as well as ours. Birthdays and other special occasions should be celebrated with parties. A crowd of young people and something to eat are a party already. If anything more elaborate is desired, there are books showing how to play games, charades, and so forth. Many of the farm papers and women's magazines give such suggestions, too.

**Rooms.** Young people should be free to bring their friends intc the home at almost any time. They should have their own rooms, in which to keep their treasures and where they may see their friends. There are large farmhouses in which children cannot tell from night to night in what bed they are to sleep; who have only the space they can find in other people's clothes closets where they can keep their things. Children treated in this way certainly are not receiving their just share of the home, and it is not likely that they will be fond enough of it to stay there when they reach the age of independence.

Give a girl an almost empty room, freedom to use what she likes out of the attic, a few dollars, and a little time, and see what she will make out of them in the shape of a room. And see, too, what that room will make out of her in the shape of a happy, efficient home girl.

There is a general idea that boys do not care about nice things. It is true that they do not want "girly" things; but, if we give them a den of their own, they will soon fill it with school trophies, collections, chums, and laughter. We should let them have plenty of drawers and cupboards, and give them a good mirror and decent washing arrangements. They will appreciate these, and feel that we really want them as partners and that we are helping them to make themselves fit. The spirit of affection will bless the home.

**Spending money.** Every child should have some job for which he is paid, and the pay should be the same that we would give a stranger of the same ability. Nobody who has not a little change in his pocket can feel much self-respect. Instead of paying in cash, it is sometimes better to lease boys or girls some land, allowing them what profits they make.

**The spirit of helpfulness.** Little children love to be helpful, or what they consider helpful. But it is sometimes hard to be patient with their slow, unsatisfactory efforts. In fact, in a busy home, it may be impossible to wait upon them. Yet to say again and again, "Oh, you don't know how; I'll do it," is to refuse them the training which is their share. Without such training, they will grow into the boys and girls who allow their elders to shoulder all the hard work while they stand by. We blame them, but the fault is ours. Every age beyond infancy has its powers of real service, and we should give to each child work to which he is suited. The fact must be impressed upon the child that he is helping; that every one must help, in order to get on in life and to be happy and decent. So all fit in together, and there is no feeling that "Mother would rather do it herself." This training may cost us time, strength, and property for a number of years; but, unless we give it to our children, we are not granting them what is their due. Life has little use for the man or the woman who has not been trained in the spirit and habit of service.

**The ability for leadership.** The cry of the countryside is for leaders—men and women who will stir their communities and organize them into working units for better homes, farms, schools, churches, and health.

**Comradeship.** The spirit of leadership is born of comradeship and play. This may seem a strange statement; but, indeed, it is a true one. Young people measure their strength against one another; they find out their weakness and their strength by contests, intimacies, and even fights. Although they get much knowledge out of textbooks, and much polite behavior from the instruction of

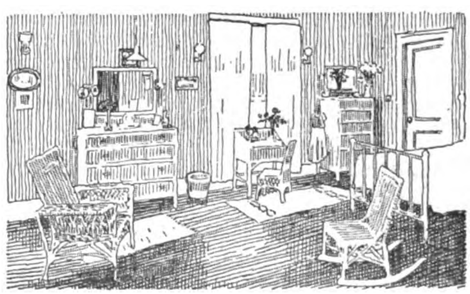


FIG. 224. The farm girl should have her own room in which she can and will take pride, and learn invaluable lessons in neatness and good taste.

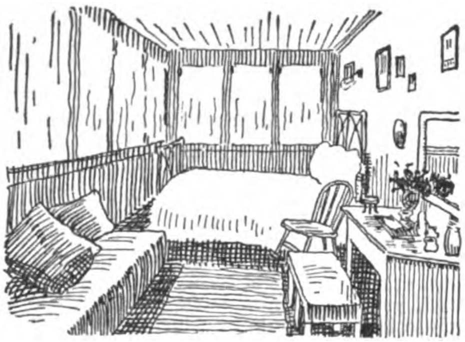


FIG. 225. A simply, inexpensively finished and furnished room that the boy knows as all his own, will do wonders in keeping him on, and interested in, the farm.

their elders, their most vital, developing education comes from personal experience; from discovering, for instance, how the boys and girls of their village regard certain acts; what are the consequences of these acts upon their lives; and what public opinion has to say about the boy or the girl who does not play fair. These things are life—life under a reducing glass, but real, true life, nevertheless.

**Fights.** No grown-up is capable of giving a boy all the education he needs. His playmates must give him a share of it. So will he learn to work with other men, to control himself and them. Without friends, freedom, and fights he will not have had his share of preparation for life.

**Play.** It is important to remember that a child's play differs from the recreation of men and women. A child's play is a form of work, an imitation of the activities and labors of mature life. Children play school, store, motherhood, and war. Play prepares them for the business of later years.

Large cities have awakened to the fact that their criminal classes are, to a great extent, made up of men and women who, as children, lacked the time or the place to play. At large expense, therefore, cities maintain playgrounds and parks where men and women are employed to teach boys and girls how to play. Because these children have not meadow and brook, hill and river, many sorts of machines are set up on these grounds for their exercise and amusement. Now, the country has the most splendid opportunities for play, but too often it has neglected them. It must admit the mistake and teach its children to play, or, rather, give them the time and liberty for play. Machines and instructors are not so much needed by country children as by city children, although on the school playground these have their place. The trout brook, the woods with their four-footed creatures, the trees with their fruits and nuts, the hills, the millpond, the river are better than anything that a factory can turn out. Well may we give our boys and girls a half-holiday every week, and a week or two every summer for camping, and see how much reverence for the world of nature, how much self-control, and how much knowledge of people they will gain by these experiences of play. Thus the country, too, like industry, will have its "captains," who are strong and wise in the management of men and women and in the organizing of country forces for the highest expression of country life. If we give our children their share of play, they will, in turn, teach the country to yield to us and to themselves the full measure of prosperity, education, health, and amusement.

**Reading.** Boys and girls who are not given opportunity to read are not receiving their share of life. In our desire to make our children's reading "improving," we are in some danger of making it narrow. The person who reads for information only, may be a splendid student, and successful in a chosen occupation; but he will not be a leader. Farmers' bulletins, farm papers, agricultural and home-making books certainly ought to be read by every farm family; but, unless boys and girls, in addition to these, are taught a wider use of literature, they are not being trained for the broadest life.

The very best way to teach young people the joy of reading is to turn them loose very frequently in a library which has collections suitable to different ages and tastes. Here they should be allowed to handle books freely, reading little or much of them, just as they desire, thus learning for themselves what they prefer. An occasional suggestion from an older person will be helpful, but "courses" prescribed by grown-up instructors are apt to kill the fine flavor of adventure which comes from wandering at will through tempting volumes.

So far as possible, let boys and girls choose their own books, after you have placed good ones within their reach. So-called "boys' books" are the best reading for girls, too, because they fire the spirit with a desire to be a hero, instead of ripening at too young an age the desire for lovers. Even the so-called "blood-and-thunder" stories of adventure, in which many maturing boys delight, are probably less harmful than the sentimental, goody-goody, falsely romantic stories in which too many maturing sisters have delighted.

However, if boys are fed on the right kind of adventure tales, written by the great masters of story-telling, and if girls, too, grow up with an admiration for ancient deeds of bravery, neither will crave objectionable literature. On the other hand, a boy or a girl with an imagination, whose reading has been limited to what grown-ups consider improving, is very likely to rush off explosively some day into the book world of exciting piracy, crime, and love. It is our fault; we have not

allowed a just share of what youth craves.

The opportunity to borrow books from public collections has brought the big world right into the farm home. Yet there are certain books—little slices of the world which we want to own rather than borrow, which we love and wish to own, keep, and reread. The children, too, should have a shelf for their own favorite stories.

If we have been able to turn the children loose among many books, they will know what they want to own; if not, we must depend on the teacher or the librarian to help in making a selection. In choosing, there are three facts to remember, which are often overlooked when old heads try to be wise about what children will like.

The first is that children are not, as a rule, interested in stories about children. They want fairies, heroes, and great deeds. This is especially true of boys. The second is that books for children must have pictures. The third is that children pass quite definitely through three stages of taste in their choice of reading matter: (1) Fairy tales and tales about talking animals. The love of these begins before they read to themselves and continues till they are 8 or 9 years old. (2) Legends and stories of knights, kings, courts, and ancient battles, and true stories about animals, especially wild ones. These fascinate them up to the age of twelve. (3) History in its purely story form—mainly deeds of brave pioneers, soldiers, and inventors. The enjoyment of these may last into adult life, or it may be followed by a real literary taste and judgment, leading through any of the book paths of the grown-up world.

## BOYS' AND GIRLS' ORGANIZATIONS ON THE FARM

*In discussing ways and means for making child life on the farm richer and more fruitful, it must not be forgotten that already a good deal has been accomplished in that direction along several lines. One of the most successful developments has been that of the club work among farm children which has served to keep many a boy and girl close to and interested in the farm. The first part of this article briefly describes the nature and development of the work. The second part, sketching some of its results, has been especially prepared for* FARM KNOWLEDGE *by* MR. O. H. BENSON, *of the Department of Agriculture, who for several years has been a national leader in the work, and who has, therefore, had unequaled opportunities for studying its effects, not only upon club members, but also upon all with whom they have come in contact.*—EDITOR.

WHAT they are. The desire of boys and girls on farms to possess something—a pig, a hen, or a piece of ground—for their very own has led to the organization of a large number of clubs in all the states of the Union. The United States Department of Agriculture, cooperating with the state agricultural colleges, has given considerable attention to their promotion; and the movement spread with such rapidity, since it was begun (about 1906 in the southern states and about 1912 in the northern states), that by 1918 more than 1,500,000 boys and girls were enrolled as members in the various organizations, which include the following projects: alfalfa, corn, farm-and-home handicraft, farm-management, forage, home-garden and canning, home-management, market garden, pig, potato, poultry, sewing, and sugar beet clubs.

State leaders in club work, paid partly from Federal and partly from state funds, work mainly through the county agents, club leaders, county superintendents of schools, and local teachers. The members of the clubs also receive complete instructions by mail both from the state colleges of agriculture and from the Department of Agriculture. Thus the corn clubs are taught the best way to fertilize their plots of ground, to select seed and prepare the seedbed, to plant, and to cultivate, while the girls are instructed how to handle their patches of tomatoes or other vegetables, and how to can or otherwise dispose of the product.

**The pig club as an example.** Perhaps the most interesting of the animal industry clubs are the pig clubs, which, in 1917, numbered more than 10,000 members. One of the first boys' and girls' pig clubs was organized in Caddo Parish, Louisiana, in 1910, with a membership of 59 boys, as an outgrowth of the corn-club work. The objects of the club were "to interest the boys in swine production, to teach them improved methods of raising and fattening hogs, the value of forage crops, sanitation, good management in handling swine, methods of home curing of meats, and, by means of the pig-club

work, to give the boy a broader and better view of farm life, thus making of him a better future citizen."

Each club member is required "to secure a pig or brood sow, and feed and care for it according to instructions, keeping complete records of the amount of feed consumed, the gains in weight, cost of the gain per pound, breeding records, etc." The pig-club work is

FIG. 226. A pig-club member and his prize-winning entry. He and his father started even, with equally good animals. The man fed his as he had always done; the boy practiced modern advanced methods and turned out a far better, larger animal in less time.

divided into two principal sections: (1) that of raising litters of pigs, and (2) that of fattening hogs for home consumption or for market. Annually, at the state fairs and elsewhere, exhibits of pig-club pigs are held.

How eagerly the project is taken up by the boys may be gathered from the fact that at Midland, Texas, a lad of 6 years secured a purebred pig and applied for membership. He was too young for admission, but, undiscouraged, he persevered with the feeding of his pig according to the regulation instructions; and, when the fair of 1915 took place, the pig, not quite 11 months old, weighed 450 pounds, securing, in certain classes to which it was eligible, no fewer than 5 blue ribbons besides $25 in cash.

**Educational value of pig-club work.** Perhaps the most remarkable result of pig-club work is its educational value both to the members and to their parents. Many farmers, after seeing the results of their boys' pig-club work, have changed their methods of handling hogs, with considerable pecuniary benefits to themselves. Also, on the children themselves the educational influence of the clubs is noteworthy. The Year-book of the Department of Agriculture for 1915 cites the case of "two boys who were somewhat dull and who disliked study and books in general, with the result that they always stood near the foot of the class, despite the efforts of teacher and parents. Both boys joined the pig club, secured pigs, and . . . read all instructions furnished either in the bulletins, circular letters, or personal letters. . . . Each read everything sent to him and finally began reading and studying other matter, with the result that these boys were among the best pupils at the close of the school year."

What has been said of pig clubs with reference to their influence on the members applies more or less to poultry, corn, canning, bread, garment making, and other clubs. Especially is this the case from the educational standpoint. A Texan county school superintendent reports that boys and girls who were club members did 23 per cent better in composition, 16 per cent better in spelling, and 11 per cent better in other subjects than the other boys and girls. Also that of more than 4,000 boys and girls in the rural schools of his county not a single member of a club had been suspended. There is a better attendance among club members, too, by 5 per cent at church services and 7 per cent at Sunday schools, than among other children.

## Boys' and Girls' Club and Farm Project Work

(*By* O. H. BENSON.)

**Its far-reaching results.** Through this method of education, boys and girls are led naturally to a proper appreciation of the ordinary activities of the home and the farm. This comes through contests, the club group, achievement-day programs, the privilege of winning and wearing achievement medals, banners, and pennants, the participation in club yells, songs, and the like. It is easy to understand why all the "stingers of farm drudgery have been pulled," and hard work has been transformed into interesting contests or work in which children love to have an active part. This type of work is based upon the belief that, if young people are given sympathetic and efficient human leadership in their work and the latter is properly staged, such work will become as interesting as the hard work connected with football, baseball, lawn tennis, and field

sports of every kind. To require a boy to work 10 hours per day in plowing, cultivating, milking, and choring, all without spirited leadership, without play, without contest, and even without the school recognizing this type of work as a standard of achievement worthy the real man is not reasonable; and it is easy to understand why he will wish to leave the farm and its tireless, endless drudgery.

Club work has for one of its cardinal virtues the teaching of ownership as well as partnership in farming and homemaking. In addition, it assigns to every child a man's or a woman's job, and lets the children know that they will have a chance to do such a job and win laurels from, and the favorable commendation of, their elders.

Fig. 227. A city boy member of a canning club. Even a backyard garden paves the way to this kind of training and education.

Many thousands of boys and girls every year have, through corn, pig, poultry, garden, canning, and garment-making projects, made net profits, on their own money and energy invested, far in excess of the profits made by their fathers and by their adult neighbors. These net profits have become their own bank accounts, or their investments in pure-bred stock, acres of land, good machinery, kitchen or household equipment. Junior farmers, through this type of education, are able not only to study the theory of the germination, growth, and development of a grain of corn, but to learn its real lesson by means of a concrete demonstration on the soil and in the market; and they have found out that the investment of skill plus knowledge in farming is what makes for the greatest net profit per dollar invested. In this type of education, the child is unhampered by years of improper habits in farming and home making. Training in school includes how to study, to apply knowledge, to follow instructions, and to take directions from others. This makes it possible to get 100 per cent value from instruction through club and home project activities.

This type of work operates along the line of giving thrift education through the production of money or other wealth. No one has ever learned properly how to save a dollar until he has first learned how to produce that dollar by means of his own investment of time, money, or energy. Thrift is a by-product of earning.

If it is worth while for adults to organize themselves into granges, women's clubs, societies, lodges, and the like for social and educational advantages, it is even more important that some form of organization be offered to children with a view to their more complete education as social and coöperative units representing the community and social ideals of the future. To encourage the organization of coöperative groups of men and women and to deny such privileges to boys and girls is unfair to the future American.

The training for leadership and coöperative efficiency is one of highest importance in the education of our boys and girls. It is, therefore, simply a matter of common sense that we give to the boys and girls ownership, a liability and a motive for their study and industrial achievement, a coöperative interest not only in their own work, but in the whole business of farming and home and community making.

**Leadership and organization.** The boys' and girls' club work is financed (1) by the Federal Department of Agriculture through its annual appropriations from Congress; (2) through the Smith-Lever appropriations, which authorize the coöperative extension work of the Department of Agriculture with state colleges of agriculture in all states of the Union; (3) by state appropriation acts for extension work; and (4) by special appropriations, as those for

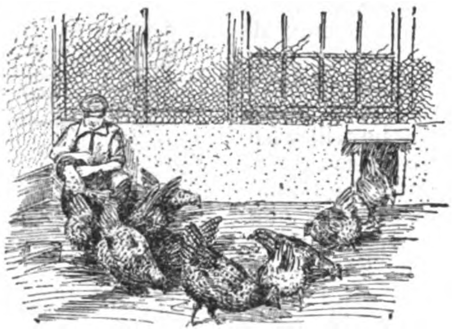


FIG. 228. A poultry club member and his flock. The best of this kind of work is that it pays while it teaches

food production and food conservation, when emergency demands. All these funds are supplemented by county and local funds. In connection with the expenditure of these funds, the United States Department of Agriculture employs leaders and specialists who direct the nation-wide work. They assist in the preparation of literature, the holding of training schools for leaders, the preparation and approval of project agreements, project programs for the different types of work undertaken, and in the general supervision and direction of the work throughout the country.

In coöperation with the state colleges of agriculture, leaders in charge of the boys' and girls' club work and other forms of junior extension work are employed together with their assistants, specialists, and district and county club leaders. In the local community, the boys and girls grouped on a certain or definite project are organized into a club, a volunteer leader is selected, and he gives instructions for the immediate needs of the work. In most of the counties in the various states, there are leaders who direct and supervise the boys' and girls' work. It is their particular duty to join up and fit in their work with that of the county agricultural agent, the home demonstration leader under the direction of the county farm bureau which is the parent organization within the county. The relation of the county club leader with the boys and girls in this type of work is very much the same as that of the county superintendent of schools to the teachers and the children who attend the schools of the county. It will be of interest to know that, in most cases, the county club leader and the county superintendent of schools plan their work together, and thus form a very effective team, in the interest of practical agriculture as well as revitalized school work. The coöperation of the teacher and the boys and girls of the farm and in the home makes the work in the schoolroom as well as that on the farm more effective, practical, and interesting. Thus do the future farmers and homemakers of our country find a new motive for their daily duties.

FIG. 229. A Boy Scout camp in which are developed the same traits of independence, self-reliance and industry as are gained from an interested life on the farm.

Club work furnishes the opportunity and machinery for practice, and carries the work through the week-end holidays and summer vacations. The school, during the 9 or 10 months of its duration, is able to give a great deal of subject-matter instruction and to reinforce and make more practical the courses and studies in vocational agriculture.

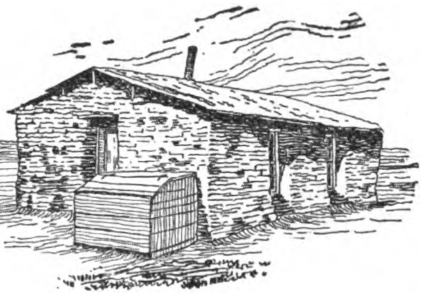


FIG. 230. Many a farmer of an earlier generation got his education—when he got any at all—in a sod school-house like this

# CHAPTER 14

# Modern Education for the Farm Boy and Girl

THE time has passed when the farmer could rely solely on the strength and skill of his hands and his body to bring him success and prosperity. With the gradual recognition of farming as the complex, scientific business that it is, has come, also, the realization that the well-equipped, well-trained brain and its careful, constant use, are equally, if not more, essential factors in agricultural progress. In other words, the modern farmer, no less than the skilled worker in any other professional line, is ready for, needs, and demands education.

Not many years ago the comparatively few determined men who spent two, three, or four seasons at an agricultural college received, upon graduating, not only their diplomas, but also the unsympathetic, scornful laughter of those "practical" men whose prejudice against "book knowledge" was equaled only by their ignorance of what it taught and really meant and offered.

To-day, the result of education is seen on farms in all directions: it is echoed at meetings of farmers everywhere; it is at the bottom of the farmer's rise into positions of service and responsibility in the interests of his community, large and small, local and national. More than this, it has in several instances been actually measured in terms of the most convincing type—namely, cash profits. Prof. O. R. Johnson of the University of Missouri, by analyzing the records of some 600 farms in a typical farming section, found that of the farm operators who were losing up to $500 per year, but 15 per cent had received more than rural school education; of those making from nothing to $200, 13 per cent had progressed beyond the elementary grades; of those making $201 to $400, 12 per cent; of those making $401 to $600, 14 per cent; $601 to $1,000, 16 per cent; $1,001 to $2,000, 25 per cent; over $2,000, 44 per cent. In other words, the largest proportion of the better-educated farmers was found among those making the best incomes.

As the result of a similar investigation of the affairs of a much larger number of farms in central New York, Prof. G. F. Warren of the Agricultural College of that state, found that those farm owners who had gone only

to district school were making annual labor incomes averaging $318; that those owners who had gone to high school were making $622; and that those who had received more than a high-school education were making a labor income of $847. Upon such a basis, "a high-school education is worth as much to a farmer as $6,000 worth of 5-per-cent bonds."

This is the crude, business aspect—the aspect which, perhaps, makes the best entering wedge for the discussion of the subject as a whole. But there are other reasons than an increased ability to make money that make education worth while—indeed, worth fighting and sacrificing for. Some of these are discussed at some length in this chapter; others, merely mentioned, the reader can rediscover and elaborate for himself.

The chapter includes also a brief descriptive survey of the agencies and sources through which the boy and girl of the farm—and the man and woman, too—may prepare and equip themselves mentally for the life they are given the opportunity and privilege of leading. In its breadth of purpose, depth of importance, width of interests, and height of nobility, farm life is more worthy of all the very best that is in them than they ordinarily realize. That it may often have appeared sordid, monotonous, fruitless, is probably true; but to eyes and minds opened and enriched and broadened by education, it need never and should never appear so again.—EDITOR.

## THE VALUE OF EDUCATION TO THE FARMER

*By* FRED H. RANKIN, *farmer and educator, who has been a member of the faculty of the University of Illinois and in charge of its Agricultural College of Extension since 1901, and Assistant Dean since 1911. For 15 years he owned and operated a central Illinois grain and stock farm; for 12 years he was Secretary of the Illinois Livestock Breeders' Association. He has been and is an institute lecturer in several states, and a contributor to the agricultural press as well as an author of university extension publications.*—EDITOR.

BY EDUCATION I mean that training which fits men and women for all the duties of life. So-called practical business and education are getting closer together. The day seems to be dawning when specialization in education will be the rule. Agricultural or commercial life is different from professional life; and, therefore, the education for each should be different. The right kind of education pays. A man's worth as a citizen depends upon his brain power and the use he makes of it. From his head down he is physically worth but about a dollar and a half a day. If he is worth more than that, it depends upon what he has stored away in his head and the use he makes of it.

Studies made by the United States Bureau of Education show that at 25 years of age men who had spent 4 years in high school were receiving $860 per year more salary, and that in the 7 years' work following a high-school course they received $2,225 more money than the men received who left school at 14 years of age and had been working for 11 years. Do you know that each day a boy goes to high school and improves his time he adds $9.25 to his earning capacity? Unless a boy can earn $9.00 a day, he had better go to high school as a matter of simple business. And yet over 80 per cent of our boys and girls have been leaving school before reaching the high school. Education pays in dollars and cents, to say nothing about what it means to your farm, your business, and your community in the way of increased efficiency.

**What is a boy worth?** The accident-insurance companies say 2 eyes are worth $5,000; 2 arms, $5,000; 2 legs, $5,000—a total of $15,000. A thousand

boys and girls figure up, in round figures, an investment of over $15,000,000. This, plus good health, ambition, perseverance, and determination to do something worth while in the world, makes an asset beyond all price. What are you as an individual or a community doing to get the best out of your boys and girls? Are you helping them to start right? Are you preparing them to fit into the world's work? *Are you training them for citizenship?* Think it over!

FIG. 231. Let the education of farm boys and girls deal with those objects and problems which will largely make up their later workaday lives as well.

**A vision fifty years hence.** Every farmer and every business man should look into the future and ask himself this question: "What will my farm or community be 25, 50, or 100 years from now?" The answer is: "It will be just what we make it—we who live here." Self-satisfaction and contentment with present conditions are the great bars to progress. To quote Professor C. M. Burritt, "There exist in every community the forces and ability to solve that community's problems. They may be, and frequently are, undeveloped, but they are none the less there. These forces must be sought out, stimulated, trained, and developed and then applied to problems of the community."

If every boy or girl could truthfully say, "Somebody in this community is interested in me," what a wonderful thing that would be. Perhaps it is the young person next to you who needs the advice of ripened experience. The thing to do is to lend a guiding hand and to help the boy and girl before they get on the wrong track. The same misdirected influence and energy that land the boy in the reform school or the penitentiary will, if rightly directed, put him in line for good citizenship and make him worth something in this world. In the majority of cases, the wrong person had got hold of that boy at the critical time. The acquiring of the right kind of ideals and training for efficiency will help boys and girls to find their places of greatest usefulness.

**A country's greatest asset is its people.** American agriculture is being made and developed by its men and women. This land of ours was not worth anything when savages roamed over it; but, as it became settled and developed by an intelligent people of vigorous thought and well-trained minds, there followed the blessings of civilization, democratic freedom, religious liberty, and a home-owning and home-loving people, the very safety and permanence of which we are now fighting for. The surest solution of present problems in agriculture is the giving of encouragement to all phases of agricultural activity. The boys and girls of to-day will run the farms and manage the homes of the future. They must be educated in the accumulated knowledge of our best farmers and agricultural scientists. This is what real agricultural education means.

**Lay plans for human efficiency.** Our most progressive agricultural students and wisest legislators are arranging to provide the best in educational facilities. This good work is seen in more liberal appropriations, both state and Federal, for the improvement of agriculture, and in the work of the farm-

Fig. 232. A poor country school in which the lack of inspiration, adequate facilities and physical comfort makes effective mind and character building almost impossible.

ers' institutes, the establishing of extension schools, the appointment of county agents, community advisers, etc., whereby the more scientific truths concerning the fundamental knowledge of producing crops and raising livestock are brought within easy reach of the farmers. These agencies, if rightly improved, together with the hearty coöperation given by our public schools in vocational training, will bring greater efficiency to the producing class of the future. But, to insure such conditions, the farmer must keep pace with all other classes in financial, social, and educational development. The farmer of the coming decades must know more of the care and treatment of soils, of the mixing and balancing of rations for feeding livestock, and of the marketing and best manner of disposing of his products.

Business management on the farm must receive more attention. The idea that we have worn out our soils at this early stage of our national existence is all wrong. These acres, depleted in fertility by ignorant and careless methods, can be made more productive by judicious and intelligent work. Our soils are not worn out; rather it is some of our methods that are worn out. With the proper application of scientific knowledge, as taught in our colleges of agriculture, combined with the best experience of our most successful farmers, properly applied, we can materially increase the productive capacity of our land.

Fig. 233. The rural school does a big enough work to deserve a healthy, attractive, accessible site.

The time is at hand when we must avail ourselves of every agency that will help us to enlarge our production, so as to meet the increasing demands made upon us by a rapidly increasing population and a world-wide food need.

**Do not be a misfit.** Among the greatest tragedies of any community are the "misfits"—men who have not been able to find themselves because they were not trained or fitted to do any particular kind of work. There is urgent need of trained and thinking men and women possessing boundless enthusiasm, and having high ideals, intellectual and moral. In each successive decade there is a smaller sphere for the uneducated man, and a diminishing possibility of success for the man who does not read and think. The reading man is in the saddle. The thinking man is guiding our nation's destinies.

To every young man comes this personal question, "Will you embrace the opportunity afforded by the agricultural college, the experiment station, and all other agencies that are or may be instituted by our state and National governments, to go forward to higher, nobler, and better farming?"

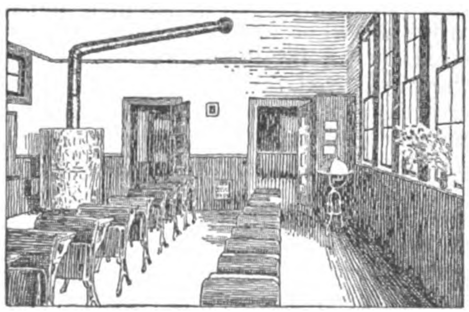


Fig. 234. Like that in Fig. 232, this is a small, inexpensive one-room country school, but its correct lighting, first-class equipment and cheerful atmosphere enable it to do all that the other finds impossible.

# DISTRICT AND CONSOLIDATED SCHOOLS

*By* MRS. HELEN JOHNSON KEYES *(see Chapter 10), who acknowledges that her deepest interests are wrapped up in the problems of giving farm boys and girls a better chance. Whosoever is thus interested is well fitted both for the careful study of conditions as they are and for the formulation of plans for new conditions as they might and should be. The district school has long been the first spring at which the child of the country could obtain draughts of knowledge. Often these were scant and insufficient; often their source was choked with limited means, lack of interest, poor location, and other disadvantages. However, the district school played and is still playing its part; and its work, its advantages, its disadvantages, and its accomplishments, as compared with those of its "big brother" the consolidated school, make an interesting and profitable subject for review.*—EDITOR.

IT IS the function of the country school to create, train, and maintain an efficient citizenship on the American farm. The school owes its service not alone to the families represented in it, not alone to the district, county, or state, but to the entire Nation.

## Changes in Educational Ideas and Methods

**The old order.** At the beginning of our history, the farm home was a little world within itself. The farm family made all the cloth and clothing required for its own use, relied almost wholly upon the farm for food, did its own carpentering and blacksmithing, and was, in short, independent of all other farms and all other industries. The little district school supplied, during its short and broken term, about as much learning as was of use to the men and women whose lives, almost from infancy to old age, were spent in home pursuits. In those days, the farm itself was the real school.

Country life then began to change. By the year 1865, all the work of growing wheat and corn, except the husking of the latter, could be done by machinery. The labor power of one man was thus greatly increased. Thousands of miles of railroad and telegraph wires covered our country, and people began to have more to do with one another. Soon products traveled over the whole world. Refrigerator cars, installed in 1869, made possible long-distance freighting of perishable crops. The farmer became a merchant, as well as a tiller of the soil; and he needed to have a new body of knowledge for this work.

A drift to the cities began. By 1890, farm tenantry had become a serious problem. All this time much of the soil, poorly cared for under a short-term lease system, was growing poorer, and the tenant, getting little profit out of it, went from one farm to another. Under these conditions, he had little interest in community life or in book education. In fact, he had no time for these things. So the country schools became of still less value to the country child, owing to the fact that the studies and methods were copied from city schools. The fact that as the twig is bent the tree grows was lost sight of. All this time country-born children were going to the city. It would have been stupid of them not to do so; for their education had prepared them to succeed better as tradesmen, clerks, or mechanics than as farmers.

**The new idea.** Then the nation woke up to the harm it was doing itself by educating its boys and girls away from the farms. A new kind of rural school began to appear—a school where agriculture was the soil in which all the studies were rooted. This type of school met with opposition, even from the parents of farm children, for they themselves had been trained by the citified rural schools to feel that farm knowledge is inferior to what the town teaches. Fathers and mothers wished their boys and girls to go to the city, because they believed city life to be easier and, somehow, finer.

FIG. 235. In eight district schools in one Ohio township were held, one year, 46 daily classes of one pupil each. On a basis of cost alone such education is inefficient.

But, little by little, two facts were made plain. The first was that by following certain laws and by cultivating the farm in certain ways, the labor might be made lighter, the income larger, and the freedom greater. The second fact was that putting agriculture in the school course did not mean that only farming was to be taught, but that the laws and sciences on which farming is based were to be made the means of teaching not only farming, but a great deal more.

**The teacher.** There is no longer any question but that this new method and the new course of study are good things; but many problems remain to be solved, and there are difficulties to be overcome. Chief among these difficulties is, perhaps, the scarcity of teachers prepared for the task by the right experience, tastes, and sympathies, as well as training. Summer schools and special courses of education are open to them, where helpful training may be secured. Without doubt, however, rural-school teaching requires much more than mere knowledge. The teacher must love country life and must understand country people. For the best work, to knowledge must be added zeal, enthusiasm, and earnestness born of the heart. The girl who is merely supporting herself till a city position offers, or who is able to put up with life in the country only by the relief of week-ends in town, may do more harm than good. The city provides plentiful entertainment for those who are empty-headed or who are unable to amuse themselves. The country, on the other hand, demands of the people that they learn to provide their own amusement and pastimes.

**The consolidated school.** Formerly, in the country, we had only the district school. There was but one teacher; and the pupils all lived in the district, which extended from 2 to 4 miles in each direction from the little schoolhouse. Later, the work of this one-room school was increased by the creation of the consolidated school.

The advocates of the consolidation of a number of ungraded schools into one central, graded school, equipped with scientific apparatus, urge that only by this method can sufficient funds be secured to put into operation the most effective teaching. On the other hand, many parents object to their children having to go to this more distant school, which keeps them from home all day, frequently subjects them to extreme cold, and sometimes exposes them to bad moral influences within the closed vehicle in which they ride to and from school. On these daily journeys, one evil child or an intemperate or vicious driver may exert a very harmful influence. However, the dangers of exposure to cold and to evil influences may be met. The wagon may be heated by a small, perfectly safe furnace, offered on the market for this purpose, or hot bricks and heavy rugs may be used. There are trustworthy drivers who can and must be chosen for the task. All-day absence of the children from home is unfortunate; but, when they weigh this disadvantage against the advantages of a hygienic building in which the children may do the best work, and where the courses of study are such as to help farm boys and girls to become efficient farmers and housekeepers, most parents will feel that the sacrifice is worth making.

On the whole, consolidation of the rural schools—the joining together of two or more districts—has been and is the most important movement in the education of the farm child. The average one-room school of the district or township has not been able to hold the majority of its pupils for more than 4 years. Why? Because the farm child, who is in close touch with practical things, condemns as a loss of time schooling which has no direct effect in fitting him for his life work. Generally, the district-school term is short. Attendance is often light and irregular, partly because of lack of interest, partly because of heavy farm and home work, and partly because of impassable roads at certain seasons. So the work of the average one-room school is poor.

On the other hand, the consolidated schools are well attended; they retain a very large number of pupils between 14 and 18 years of age. Where the consolidated plan has been tried, there is no inclination to go back to

the old type of school. On the contrary, consolidation, which has the approval of the best educators, continues to grow in favor.

Professor A. W. Nolan (p. 276) says of the consolidated school: "The consolidated elementary school, by the very nature of its organization and supervision, is in every way better prepared to give more satisfactory instruction in agriculture, as well as in all other branches of study, than is the one-room district school.

"'What the best and wisest parent wants for his own child, that must the community want for all its children. Any other ideal for our own schools is narrow and unlovely; acted upon, it destroys our democracy.' These words of John Dewey strike the keynote of education in democracy. The growth of the consolidation idea is an indication that our rural communities are seeking to give all the children of all the people the best opportunities for education that they are willing to improve. We must not, however, be misled into the belief that it does not cost more to maintain a consolidated school than the district system. All improvement costs something; and when we learn from statistics that the cost per head of the education of the city child is, in nearly all instances, twice that of the country child, we cannot, in justice to the country boys and girls, object to the added cost of the consolidated schools. So long as the ordinary one-room district school remains the sole educational center for country boys and girls, we shall go from bad to worse in rural life, no matter how many farm experts may be employed, or how profitable farming may become, as no one will rest content to have his children go out into a world of fierce competition with only one half or two thirds of the education accorded to other boys and girls.

"A few of the advantages of the consolidated school may be listed as follows: (1) Increased school enrollment and better attendance; (2) fewer absences and tardinesses; (3) pupils arrive at school dry and warm; (4) pupils are usually under supervision on the way; (5) larger classes and better grading; (6) fewer classes to the teacher, longer recitation periods possible; (7) opportunity for introducing vocational courses; (8) better physical equipment; (9) longer terms; (10) better teachers; (11) closer supervision; (12) community-centre work made possible; (13) recreational opportunities afforded; (14) eliminates many school officers; (15) fosters good roads movement; (16) less waste; (17) awakens community pride; (18) makes community high school possible. The disadvantages of such schools, often urged, are: (1) Depreciation of the value of property where schools are abandoned; (2) children have to attend school farther from home; (3) long rides to and from school for some pupils and long walks for others; (4) bad associations on the way often result; (5) local jealousy aroused; (6) more expense; (7) removes old landmarks; (8) bad roads often cause irregularity in attendance.

"When we come to look into these advantages and disadvantages, we see that, where physical barriers, such as too great distances, mountain ranges, impassable roads, or large bodies of water, do not intervene, there are but few effective arguments against consolidation."

**Origin of the consolidation movement.** The consolidation movement began in Concord Township, Massachusetts, in 1869, when a law was passed providing for transportation, and then 2 districts were consolidated. Within 10 years all Concord Township had consolidated, and the movement had begun to spread. During the year 1912–1913, Massachusetts spent more than a third of a million dollars on the transportation of its school-children. The same year, Minnesota consolidated 60 districts; for the system spread from New England to the Middle West and thence to the South and the Far West.

The movement has become of national importance only during the last 14 years, in which time more schools consolidated than during the 48 preceding years. It has been successful in all parts of our country, even where severe winters, spring freshets, rugged hills, large farms, and wide plains or prairies might have seemed to make it impracticable; for free transportation under comfortable conditions is necessary to the success of the system.

**Method of consolidating.** There are 3 ways in which consolidation may take place. One of these, and the most usual, is *by permissive legislation*, which allows districts to consolidate and provide transportation when they cast a majority vote to do so. Formerly, each district voted separately; but of late, in many states, the districts have voted together as units. The second method is *by compulsory legislation*, which requires consolidation of schools whose daily attendance falls below a

FIG. 236. An Idaho consolidated school in a thriving agricultural district of 36 square miles, with an enrollment of 726 including 100 high school pupils. Eight wagons transport some 200 children, all those outside the city limits being carried free. There is a 2-acre playground and a 4-acre farm that is used to supplement the indoor class work in agriculture.

FIG. 237. The conveying of children by wagon to the consolidated school has been both praised and blamed. Under favorable circumstances, it is undoubtedly an advantage.

certain average. Indiana has taken the lead in this direction, requiring the consolidation of schools with fewer than 13 pupils. The third method is *by state aid*, each consolidated school receiving annual support according to its size and teaching force. The state may also provide funds for buildings, if they attain certain standards. Minnesota and Iowa have been pioneers in this system, under which their graded schools have increased rapidly.

It has been said that consolidation is actually a cheaper way of educating children than the maintenance of many poorly attended one-room schools. The fact seems to be, however, that the consolidated school costs more per pupil, but, possibly, less per day, in view of the long term, than the district or township group of the six-month or four-month type of school. The interest on the investment—that is, the number of efficient citizens who are returned to the farm—is probably 100 per cent greater from the central schools.

**Introduction of agriculture, as a study.** Among the many advantages of the consolidated schools are the better health conditions, the well-trained teachers, the varieties of studies, all made alive and interesting by being brought into relation with daily life and with the laboratories and workshops. Greatest of all, though, is the introduction of practical agriculture into the course of study, under instructors thoroughly prepared for the work. This study has come down into the elementary schools from the institutions of higher learning. It began with the land-grant colleges in 1862, later reached the high schools, and, finally, in 1897, entered elementary education under the Nixon law of New York, whose administrator was the Agricultural College of Cornell University. Through visits to the schools, lectures, institutes, the distribution of leaflets, and the organization of boys' and girls' clubs, the work was carried on under the direction of the Nature Study Bureau. Personal correspondence had a large and useful part in this pioneer work. At first, the lack of specially trained teachers for the schools stood in the way of the establishment of agricultural courses. This need gave birth, however, to training classes in these branches at normal schools and agricultural colleges and to summer short courses. To-day nearly all the agricultural colleges are working with elementary and secondary schools in agricultural instruction for teachers and in direct work among the pupils, and the normal schools of almost all our states teach farming to the girls who are to be instructors in country schools.

A phase of the consolidation question which is frequently overlooked is the rather marvelous growth of state graded schools. Wisconsin, for instance, has about 600 of these institutions, employing about 1,450 teachers, scattered over the state. About half of them are doing some work beyond the eighth grade. Each of the schools really becomes an educational center which, in many cases, is equivalent to a consolidation center.

**Intermediate agricultural schools.** The deputy commissioner of education for the same state points out that, as a result of this movement in the consolidation of one-room schools, several schools have been organized which will do the usual work of the 8 grades in the elementary course and 2 years of high-school work. He says: "These schools are generally known as 'intermediate agricultural schools.' The courses of study are along the lines of agriculture for boys, and of domestic science and home making for the girls. Teachers of agriculture have been employed in these schools on the understanding that they do continuation work during the summer. The boys who are taking the agricultural course are under the direction of this teacher, but are employed in regular farm work during the summer vacation."

**Agriculture as nature study.** Agriculture begins in the first grades as nature study. This is an effort to make the country interesting to the little children who live in it. It then advances to more practical farming. It seems to be a fact that, to most of us, what we see every day, what is associated with hard toil and the problems of making a living, does not present itself in a very attractive light. It has required, therefore, men and women of unusual imagination, leaders in country life, to show boys and girls the science and the poetry of the soil. To find these things, they are taken out into the garden, the orchard, the field, which they cultivate according to the instructions of the United States Department of Agriculture and the state agricultural colleges, and often under the supervision of county agents. Many schools have gardens and farms which the young people cultivate; and frequently the

community interest in the experiments is so great that neighboring farms are, to some extent, experiment, or demonstration, plots for the boys and girls. Seed testing, the examination of soils, grain and stock judging, the repairing of farm machinery, and dairy and poultry problems all become a part of the school course. While all the work is made as plain as can be, thought is given to the sciences beneath—to chemistry and biology, to mechanical and mathematical laws, physiology, and zoölogy. How learned these studies sound when they are dressed in their best names! Yet, when clad in their overalls and called merely "agriculture" and "manual training," some parents and a few educators fail to see in them what they are. Arithmetic means something to a farm child when it teaches him to estimate the quantity of corn in the crib, the shrinkage of pork in packing, or the amount of lumber needed for a chicken coop. It may be impossible for him to express himself in delightful English concerning the walls around Peking or the peoples of ancient Greece, when it is easy to write about butter fat and profits and losses in milk, if he has been working with a Babcock tester at school. The difference is that he does not care about Peking and Greece and has no impulse to talk about them, whereas he really wants to tell of his experience with his father's herd. The one is hack work, the other may be inspiration. It is no less an exercise in English, because the child knows what he is writing about.

Courses in agriculture and domestic science will make the rural schools real community centres; for in the new rural school parents, children, and teachers join in working out the problems of the farm and the home.

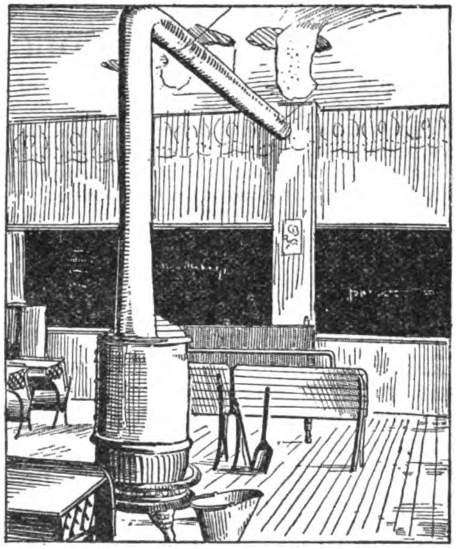


FIG. 238. The interior of a Missouri country school as a wave of progress found it. Note the falling ceiling and the dangerous, inefficient, inconveniently placed stove.

## The Future of the District School

The little district school, however, may become a powerful force for the new education and the new community life. Its doing so depends upon a good teacher and his or her power to organize and inspire the neighborhood and to make the school mean what it should mean to the farming community in which it is located. Scattered all over the country are examples of one-room and two-room district schools from which boys and girls have gone to win prizes on their exhibits at state and county fairs. This is indeed fortunate, for during many years to come the district school will remain the institution in which a very large percentage of farm children will receive all the education they get.

**County school leaders.** County superintendents and their assistants are doing more and more efficient work as their field is limited to fewer tasks and as the position is removed from politics. In many counties, it is possible for superintendents to visit all the schools every few weeks and thus to give the district teachers needed support and advice. In some states, particularly those of the South, certain supervisors are assigned to oversee special courses, such as agriculture, manual training, and domestic science.

**A premium for good work.** In order to set up a standard for the district schools, a system of inspection has been established in some places by means of which schools are classified as "standard" or as "superior," according to their site, grounds, building, furnishing, heating, ventilation, lighting, sanitation, equipment, and teaching. A diploma is awarded the schools which earn it and over their doors is placed a plate, engraved with the word "stand-

ard" or "superior," according to the work done. The effect of this standardization, or grading, which takes many forms, has been to increase greatly the number of one-room schools that are doing good work. The supporters and patrons are also given clearer ideas as to the kind of school they should provide for their children.

## AGRICULTURAL EDUCATION IN HIGH SCHOOLS

*By* A. W. NOLAN, *State Supervisor of Agricultural Education for Illinois, and Assistant Professor of Agricultural Extension in the College of Agriculture of the University of Illinois. He was born and gained experience until 24 years of age on a farm, with which he renewed active connections in 1912. He graduated from Indiana University, taught in rural schools and was principal of a township high school, professor of horticulture in the West Virginia Agricultural College, and professor of agricultural education in Chicago University before taking his present position. Fortunately for country boys and girls, for the farms from which they come, and for the country in general, more and more of them are reaching out for the advantages offered by the high school. This improvement over former conditions has come about partly because of the new and increased appreciation of the worth of education, and partly because of the splendid advances made by the schools in preparing themselves to supply the needs of the country child.*—EDITOR.

THERE is no longer any question as to whether or not agriculture should be taught in the rural schools. Sentiment and public opinion demand it, and in many states the law requires it. There are, however, still a few farmers who object to the teaching of agriculture to their children; but most parents favor a study of the vocation which supplies their means of living. The subject is vital to the life of every member of the farm family. Upon the soil, among the plants and animals, and in the open country they live and move and have their being. In its broadest sense and fullest possibilities, agriculture includes everything which enables us to teach in terms of the lives of the people and the needs of the community.

Through the teaching of agriculture in the schools there is afforded an opportunity to break away from the four walls and the bookish, impractical systems and to learn in a natural way from the real things of nature and life. Even though the district-school teacher be a woman, and not especially trained in agriculture, if her heart is right and if she is willing to learn with the pupils, a beginning in agricultural instruction can be made.

**Agriculture in district schools.** Before discussing the subject of agricultural education in high schools, it may be worth while to glance at what is being done in the elementary schools to prepare a foundation for the high-school course.

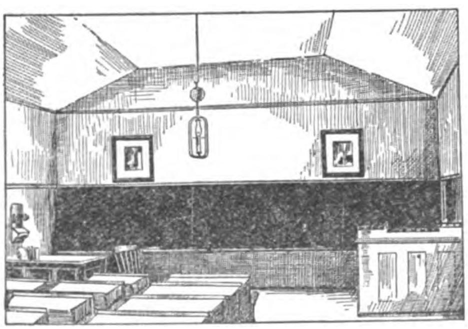


FIG. 239. The school shown in Fig. 238, one year later. A furnace has replaced the stove, the interior has been tastefully redecorated, and the desk equipment and arrangement have been greatly improved.

Agriculture, which practically begins in the early grades as nature study, is introduced into the seventh and eighth grades, and is taught in the district schools throughout the country in various kinds of courses and through widely varying methods. The most common way and the one fitting most easily into the present system is the textbook method. Each pupil has a book on general agriculture; lessons are assigned and studied; and recitations are given as in the case of geography, physiology, or any other common branch of study. An occasional field trip, demonstration, or laboratory exercise may vary the class work in agriculture. As far as this work results in the teaching of correct scientific principles which may be applied in practical vocational agriculture, it is well and good. A knowledge of principles and good farm practices, even though the pupil may

have no opportunity to carry them out at the time, is a necessary part of good practical agriculture. Dean Davenport, of the College of Agriculture of the University of Illinois, takes the point of view that if the pupil is led to a genuine interest in agriculture and in the things and affairs of the farm, even though no practical vocational work is attempted, he has made a good start in agriculture as a vocation and will make a better citizen, even if he should choose another life work.

The home-project method. Another method, coming into successful use in many states, is known as the "home-project method." In Bulletin No. 385 of the United States Department of Agriculture this method is described as follows: "The term 'home project' applied to instruction in elementary and secondary agriculture, includes each of the following requisites: (1) There must be a plan for work at home covering a season or a more or less extended period of time; (2) it must be a part of the instruction in agriculture of the school; (3) there must be a problem more or less new to the pupil; (4) the parents and pupil should agree with the teacher upon the plan; (5) some competent person must supervise the home work; (6) detailed records of time, method, cost, and income must be honestly kept; and (7) a written report, based on the record, must be submitted to the teacher. This report may be in the form of a booklet."

Pupils of the school choose or are assigned to definite agricultural projects to be worked out at home, such as growing an acre of corn, caring for a vegetable garden, keeping a pen of poultry, or raising a litter of pigs. One or two projects are carried out each year by each pupil, and the school agricultural work may be based upon the home projects. By this method it is not necessary to have many formal class-room recitations. The teacher and parents direct, encourage, and instruct the boys and girls in their work, reading, and study along the lines of the project. The boys and girls carrying out the projects may organize into a club and become affiliated with the state boys' and girls' club movement.

Elementary agriculture in the district schools is coming to have 2 main aims: (1) to teach the elementary facts of scientific agriculture and good farm practice, arousing interest in this great vocation; and (2), through home projects, to offer to the boys and girls an opportunity to do practical scientific farming on a small scale, thus contributing something to the production and conservation of the world's food supply as well as to their own educational development.

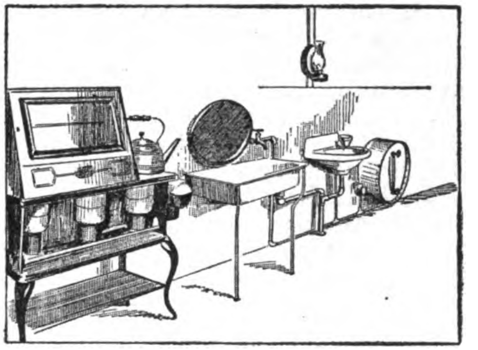


FIG. 240. The basement of the same school after two years. In addition to the furnace, it boasts a water pressure tank (*in background*), a sanitary drinking fountain, a sink, running water, and an oil stove on which the children's hot lunches are prepared and lessons in cooking are given.

When we know that the vast majority of country boys and girls never go beyond the seventh and eighth grades of the elementary school, it follows that whatever is to be done in the way of laying the foundations of agricultural knowledge in a systematic manner for the great body of pupils must be accomplished before the pupils leave the elementary schools.

There are undoubtedly very difficult practical problems in teaching agriculture in the district schools. The teacher has a great deal to do. She must conduct many recitations each day. Additional subjects, therefore, may find little welcome. In spite of these difficulties, however, hundreds of teachers in elementary schools have blazed the way, pioneered through handicaps, and found, in the success accompanying their efforts, that they have vitalized their schools, benefitted their communities, enriched the lives of their pupils, and brought success and greater satisfaction into their own lives and work.

**Agriculture in the consolidated school.** The subject matter and methods in elementary agriculture are pretty much the same in consolidated schools as in the district schools, except that more time is given to field, laboratory, and class-room work in the consolidated school than is possible in the rural school. Then, too, better prepared teachers handle the work. The home-project work also takes on more interest and admits of closer supervision and further development. The consolidated school, becoming a social center, may provide short agricultural courses and continuation schools for extension service to the people of the community. The greatest value, perhaps, of the consolidated school is that it becomes the basis upon which to build a good 4-year high school in which the vocational courses may be well organized and taught.

**Agriculture in the high school.** According to a report of a committee of the Association of American Agricultural Colleges, made in 1916, agriculture was then being taught in 4,660 high schools in the United States. This is about 40 per cent of all the high schools of the country. Over 90 per cent of these schools have introduced agriculture within 10 years; and the number is likely to increase rapidly, especially since the passage of the Smith-Hughes Bill, providing federal aid for the teaching of agriculture in the high schools of the United States.

The American high school has rightly been called the people's college; because of the institutions offering higher education it is the nearest to the masses of the people. Nothing in the history of education is more phenomenal than the growth of the high school; and with this growth, especially in the case of the community high school, has come the introduction of vocational studies. This is well, since the ideal of universal education demands a school where opportunities may be offered to all the people to enter into the educational heritage of society at its best, and into the major vocations trained for success.

Practical scientific agricultural education for the largest number of farm folks is more successfully obtained through the modern district or community high school than through the district elementary school or through the state college of agriculture. The district elementary school is nearer the farms, but the organization of the school and the preparation of the teacher will not permit work of much vocational value being done. The state college of agriculture is well equipped to give agricultural education, but not all farm folks can go to college. On the other hand, the high school, wherever established, is within reach of a very large percentage of farm boys and girls. When equipped and manned to give vocational work in agriculture, it is of real practical value.

**Courses of study.** A common outline of courses of study in agriculture, as offered in high schools, is the following: First year, plant industry (first semester, farm crops and soils; second semester, horticulture); second year, animal husbandry (both semesters); third year, the farm physical plant (both semesters); fourth year, special electives (one semester each): (1) improvement of plants and animals; (2) soil; (3) dairying; (4) poultry; (5) vegetable gardening; (6) farm accounting; (7) farm management.

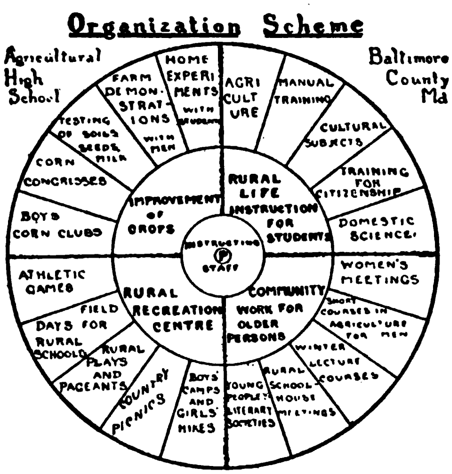



FIG. 241. Plan of a campaign for the development of a rural school, showing scope and relationship of the various agencies which can affect and be affected by its work. both within its immediate circle, and throughout its community. ("Journal of Agriculture," Univ. of Cal.)

There are several good textbooks to assist pupils and teachers in their agricultural courses. Although high-school agriculture should break away from the book for the farm, orchard, barns, and gardens of the open country, it is necessary that a text be in the hands of the pupils to give definiteness to the course. The aim of agriculture in the high school should be to contribute to the liberal education of the student as well as to his vocational efficiency. In this aim is implied the belief that its realization will satisfy society's needs and aims quite as well as the individual's. All surveys of agricultural conditions show: (a) Soil fertility not generally conserved; (b) livestock production decreasing; (c) grain production not keeping pace with the increase in population; (d) purebred stock not generally owned; (e) market facilities not adequate; (f) farm machinery deteriorating; (g) orchards neglected; (h) forests devastated; (i) labor scarce and inadequate; (j) increase of tenancy; (k) insect control poor; (l) acre income low;

(m) great waste; (n) poor organization and coöperation; (o) rural exodus.

The principles and practices of scientific agriculture apply directly to the improvement of all of the above conditions. Agriculture in the high school should contribute very substantially to the attainment of: (a) a greater degree of permanency in soil fertility; (b) increase of grain and livestock production; (c) better livestock and food plants; (d) greater control of insects and fungous diseases; (e) better roads; (f) rural organizations and coöperations; (g) conservation of forests; (h) better use and care of machinery; (i) better market facilities; (j) the retention of a larger share of the surplus profits by the farmer; (k) better living conditions in every respect.

There has been a great deal of discussion as to whether agriculture, along with other industrial subjects, should be given in the high schools already existing, or whether special schools are needed for these subjects. Those advocating the former plan contend that it is wiser to join agricultural instruction with the work now being done, and to make it a part of the educational system already established. The advocates of the special agricultural high school believe that better courses than those usually offered in the regular high schools can be worked out for these special schools, courses containing all that is essential in the old ones and, in addition, providing for training along distinctly agricultural lines.

There are many examples to show that agricultural education can be effectively given in the existing high schools. On the other hand, there are many special schools of agriculture of a secondary nature that have succeeded and served well. These schools, of whichever kind they may be, are already great channels through which the achievements of society at its best are brought to the people of the open country.

**State and county agricultural high schools.** In 1916, there were in the United States 85 special state schools of agriculture of secondary grade for white persons. In about 20 cases, these secondary schools were maintained by the state college, and had the advantage of the college grounds and instructors. County agricultural high schools seem to be the most favored of the special type. Such schools were first established in Wisconsin in 1902. These schools are agricultural trade schools. They are designed for boys and girls who are unable to attend college courses, but who desire to obtain a practical training for the farm in their high-school course. The county is the taxable unit, and the school draws its support from both the county and the state.

The congressional district schools of Alabama and Georgia represent another type of special schools giving agricultural education. Each school embraces from 2 to 9 counties, and is supported both by the district and by the state. These schools are designed to be vocational, and they emphasize the financial aspects of their instruction. The school farms belonging to them are run on a strictly business basis, unless reserved for demonstration purposes.

**Private schools giving secondary agriculture.** In many church and private business and technical schools, courses in secondary agriculture are being offered. During the present century, there have been established several private schools in which secondary agriculture and domestic science are the leading features. At Briar Cliff Manor, New York, and at other places near that city, schools for the training of city young men and women in agriculture have been established. Private schools established near other large cities and giving instruction in agriculture show the demand for this type of education. The Glenwood School for Boys, near Chicago; the National Farm School, near Doylestown, Pennsylvania; the Baron de Hirsch Agricultural School, Woodbine, New Jersey, the Mount Hermon School, near Northfield, Massachusetts, and the Wenona Agricultural School, near Warsaw, Indiana, are notable examples of these types of schools. The agricultural work done in them is usually of a high class. Land and equipment are available; the schools are on the farms; and the students get first-hand, practical work in the best type of farm operations, as well as a thorough study of the principles of scientific agriculture.

**Normal schools.** In many normal schools, courses in elementary agriculture are given to prospective teachers. State courses of study are requiring

more and more the teaching of nature study and agriculture in the elementary schools; and the normal schools owe it to the rural communities as well as to the cities to teach not only these subjects, but also the methods of teaching them in the elementary schools. Several normal schools maintain departments of agricultural education, and courses like the following are given to prospective teachers: Nature study, elementary agriculture, school gardens, soils and crops, farm animals, dairy industry, poultry husbandry, horticulture on the farm, the farm home, rural sociology, and the rural school.

Upon the high schools and the county and state normal schools we must depend for the training of elementary teachers; and upon these teachers, probably more than upon any other class, will depend the attitude of the country boy and girl toward agriculture.

## HIGHER EDUCATION IN AGRICULTURE

*By* MRS. HELEN JOHNSON KEYES *and* PROFESSOR A. W. NOLAN. *The college course in agriculture is no longer regarded as merely a preparatory step toward a lifetime of laboratory research and scientific teaching; practical farmers are finding it an invaluable aid to greater efficiency and profit making, not only because of its educational effects, but also because of its broadening tendencies and opportunities. Consequently they are sending their sons and daughters for two-, four-, and even six-year periods, and in many cases are attending, themselves, the short winter courses in which the essence of the principles of different branches of farming is offered to those who can spare only a short time from their home activities. The results are everywhere to be seen, justifying in every way the claims and expectations of the pioneers who blazed the educational trail through a hostile wilderness of doubt, ignorance, and shortsightedness. It is especially significant that, although each of the states now has its agricultural college, there are also a good many institutions of collegiate grade which, realizing its importance, have of their own accord added agriculture to their program of major subjects.*—EDITOR.

**LAND-GRANT colleges and experiment stations.** Agricultural education in the United States had its real beginning in 1862, when President Lincoln approved the Morrill Act providing for the establishment of land-grant colleges. The act was vague. It provided for the support of at least one college in each state where branches of learning relating to agriculture and the mechanical arts should be taught, in addition to the usual studies and military tactics. For this purpose 30,000 acres were given to each state for each member it sent to Congress.

By the Hatch Act of 1887, $15,000 was given annually to each state for agricultural experiment stations and research; and in 1888 the Office of Experiment Stations was established in Washington as a bureau within the Bureau of Agriculture (created in 1862) as a clearing house for the state experiment stations. This act brought into being 26 new experiment stations, making a total of 46.

FIG. 242. These hogs are litter mates. That on the left was raised by a practical farmer; that on the right by his son, a member of a pig club. This suggests what enthusiasm and rightly applied instruction can do.

The second Morrill Act, approved by President Harrison in 1890, provided an endowment for each state of $15,000 the first year, to be increased $1,000 each year till the annual sum of $25,000 for each state was reached. These funds may be applied "only to instruction in agriculture, the mechanical arts, the English language, and the

various branches of mathematical, physical, natural, and economic sciences, with special reference to their application in the industries of life."

The Adams Act of 1906 provided for the further encouragement of agriculture by granting to each state experiment station $5,000 the first year, with an increase of $2,000 annually up to $30,000. When these bequests are complete, the United States will be devoting $1,500,000 annually for experiment-station work. As the individual states are already giving more than this, some idea may be formed of the importance to the nation of an efficient agriculture and a high type of farm citizenship.

The intention of Morrill in providing for the land-grant colleges was not so purely agricultural as would be indicated by their later development. His idea was not chiefly to encourage agriculture, but to supply opportunities for a practical education which classical colleges do not give. He himself states that the name "agricultural colleges" originated with an index clerk, who found that heading a convenient one for his records of the institutions in question. Ezra Cornell's definition is contained in the expression of his desire to "found an institution where any person can find instruction in any study."

**Purpose of the land-grant colleges.** In the Morrill Bill of 1862, the purposes of the land-grant colleges were expressed in broad terms as follows: "To the endowment, support, and maintenance of at least one college, where the leading object shall be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life." The ultimate purpose of the land-grant colleges was not to uphold scholarship, but to create skilled industrial workers out of the material at hand. When the colleges opened, industrial education had not filtered through into the secondary and primary schools. The high schools were very little used by the farming or industrial classes; indeed, the majority of country boys and girls left school altogether at the fifth or sixth grade. It was from this material that the land-grant colleges recruited their students. Had they held to high entrance examinations or high-school certificates, they would have perished for lack of pupils. Now that practical sciences have become a part of the curriculum of most rural and secondary schools, these schools hold and graduate the type of boys and girls who later enter the agricultural colleges; and this changed condition is making it possible for many of the colleges to demand high-school certificates as an entrance requirement.

The charge has been made that agricultural colleges tend to educate boys away from the farms, instead of returning more efficient workers to the home acres. It must be remembered, however, that these college graduates, although they have not always returned in large numbers to till the ground, have returned to the farm as educators, agents, and organizers of rural life. When they have performed their good work as leaders, they may, perhaps, have made the farm a place to which other graduates will be glad to go back as practical farmers.

Altogether, the agricultural colleges have had a task to perform different from that which has confronted any other educational institution. They have had to create a suitable type of man and woman for the work they offered. This they have done through their graduates. They have had to think out a body of scientific knowledge from the loose medley of facts and practices which characterized farming before their labors began. They have also had to overcome the distrust of farmers and, sometimes, the scorn of educators.

**Courses of study.** The curriculum is tending to divide itself sharply into 3 courses. One of these is a 4-year collegiate course with a good standard of general scholarship. There are, also, courses of from 3 months to 2 years for boys whose homes cannot spare them longer, and for which the preparatory work has not necessarily included high school. These short terms are needed also by graduates of agricultural high schools, to whom they give a valuable opportunity for association with agricultural experts and for the use of laboratories and all the equipment for research. The farmer himself, who can leave his fields only during brief periods, finds such courses highly profitable. Into them is packed much information which can be applied day by day in the work at home. Many colleges are now dividing the school year into quarters, and this plan is proving of great benefit to boys who are needed on the farms during the busy seasons.

At the top of the college there is a demand for a school for graduate students. The work

FIG. 243. A "Better Stock" agricultural extension train. Every year sees increased development of the idea of taking education out to those who are unable to go to schools and colleges in search of it.

of these men of superior training should give birth to many new ideas and movements in agricultural life.

**Work of the agricultural colleges.** Agriculture is destined to play a large part in the future of general education. In such movements for agricultural education, the agricultural colleges obviously ought to exercise wise and influential leadership.

The purposes of the agricultural college are: (1) to give technical training in scientific agriculture and general liberal education to students in attendance; (2) to investigate unsolved problems; and (3) to extend the services of the college to the people of the state outside the college. A recent bulletin issued by the University of Illinois states: "The Agricultural College and Experiment Station were established for the advancement of farming and housekeeping and the improvement of living conditions in the open country."

An agricultural college, supported in part by Federal appropriation and in part by the state, has now been organized in every state in the United States. Some of these, as Purdue University, Indiana, are separate agricultural colleges, and others are organized as colleges in the state university, as those of Illinois and Wisconsin.

All of these colleges have had a hard fight for existence and recognition. They have had to train their own professors, to create a body of knowledge and give it pedagogic form, to break down the distrust of the practical farmer, and to secure the sympathy of sometimes hostile educators. In spite of these difficulties, they have become established on a firm foundation and have justified their creation.

The colleges of agriculture have made large contributions to the farming industry and to farm life, and have thus benefited all the citizens of the state. Agricultural colleges are nearly always managed, and the funds, both Federal and state, spent, by boards of trustees appointed or elected wholly by the state. The unit of organization and work is usually the department. The college president, or dean, is the chief officer of power and control; and at the head of each department is a strong man as chief, under whom are groups of specialists and their assistants.

The financial needs of the agricultural colleges are met by direct special legislative appropriations in the state and by such fixed annual Federal incomes as those provided by the Morrill, Hatch, and Adams funds. The states often provide a continuing tax, usually called a "mill tax," providing a fixed financial policy. The growth and needs of the colleges, however, are likely to develop faster than the funds which such taxes provide. The Federal funds for both college and station work in the leading agricultural states vary from $100,000 to about $400,000. The states have added to these funds, in some instances, sums reaching nearly $1,000,000.

**Methods of teaching.** The most important forms of instruction given in agricultural colleges are: (1) graduate teaching for advanced students who have finished a 4-year course, and who desire further specialization leading to the master's degree in 1 year, and the doctor's degree in 3 years; (2) the regular 4-year course, requiring graduation from an accredited high school for entrance, and leading to the bachelor's degree; (3) the short course, varying from 2 weeks to 2 years, giving special practical instruction to mature men, who either are already farming or will soon enter the business; and (4) the extension-teaching service consisting of movable schools, institutes, correspondence courses, lecture courses, etc., designed for those who do not attend the college, but who desire some of the instruction and other assistance which the college can give.

The major subjects of instruction in the agricultural colleges relating directly to vocational agriculture are soils, farm crops, farm mechanics, farm management, animal husbandry, dairy husbandry, horticulture, landscape gardening, floriculture, household science, agricultural extension and education. Non-agricultural subjects, such as English, foreign languages, history, mathematics, the pure sciences, economics, education, music, physical training, etc., usually make up a small fraction over one half of the college course. Three principal methods are followed in modern college and high-school teaching. These are: (1) the use of textbooks with classroom recitation; (2) the lecture, with occasional oral quizzes and written tests; and (3) laboratory and field work of various kinds.

As the colleges are now organized, there is little opportunity for the student to get any large amount of first-hand practical work in farm operations. He has the opportunity, however, to see and learn the best methods of farming as carried out on the college farms. The encampment method, through the summer months, whereby students under instruction get practical experience in forest, field, or orchard, or on livestock farms, is a promising improvement in instructional methods in agricultural colleges.

**What the colleges and stations have done.** The value of the work of the American agricultural colleges can scarcely be overestimated. Hundreds of thousands of young men and women have gone out from them and become leaders in the campaign for the conservation of the agricultural and human resources of the country. They have established modern homes, farmed the land scientifically, and raised the standards of life in rural communities. While living in the country, and laboring with their own hands, these young men and women have gathered about themselves the best things of civilization.

The colleges and experiment stations have also brought before the public, and shown the applicable values of many new discoveries such as soil surveys with definite recommendations for soil improvement, improved breeds and strains of animals and plants, control of insect pests and fungous diseases, best methods in the nutrition of plants and animals, principles of economic farm management, and better methods of marketing. Patient, capable, hard-working, scientific-research men are constantly at work in these institutions, not in the spirit of meddling with the farmer's business or showing him how to farm, but aiming to discover new facts and practical principles which the farmer may, if he so desires, use in his business for its improvement. Through its extension service the college of agriculture has broken from traditional academic subject matters and methods, and gone out from the classrooms, laboratories, and plots to give and to receive the benefits of the successful achievements of scientific agriculture. Agricultural extension service, on the one hand, has quickened the agricultural college and increased its financial support and student attendance; and, on the other hand, it has brought the benefits of scientific agriculture to the farms of the people in every community of the country.

## EXTENSION TEACHING IN AGRICULTURE

*By* MRS. H. J. KEYES *and* PROFESSOR A. W. NOLAN. *The isolation of the farmer and his family was for a long time the greatest obstacle in the path of his getting or giving his children an adequate education. The combination of time, effort, and expense required to attend anything more than the district school, put learning out of the reach of all but a few who were unusually favored. Then, at last, came the idea of taking education out into the country to those unable to get to its sources. It took root, it grew—slowly, perhaps, but steadily—and under the guidance of tireless, farsighted, enthusiastic extension workers, it spread, developed, diversified and finally became one of the most far-reaching and effective of all educational movements. In some form or phase it is already familiar to most farmers throughout the country; but in its entirety as discussed here, it may give a good many of them new food for thought, and a better idea of what has been and is being done to make farming the business and life it should be.*—EDITOR.

EXTENSION work in agriculture has been defined as "that phase of instruction which is carried on among people who are not resident students at an educational institution." It aims to make the truths already discovered available to those farmers who are actually in the field. Furthermore, it has to do not only with improved methods of agricultural production, but with the general welfare of the rural population.

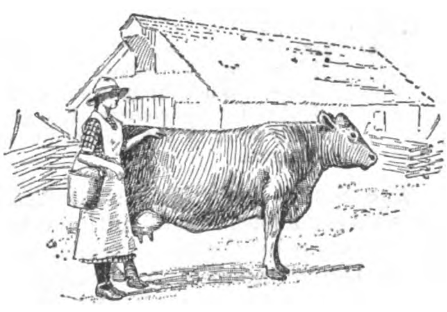


FIG. 244. Proprietorship and competition are two of the main reasons for the splendid success of the club work idea. This shows a member of a cow club, and the cow that is hers to care for or neglect, to succeed or to fail with.

**Scope of extension work.** The scope of extension work may be briefly set forth in the following outline, adopted by the Committee

FIG. 245. Members of a garden and canning club making up and packing an exhibit for a local fair. In times of food shortage, more gardens mean less hardship and better health, as well as more capable farm boys and girls.

on Extension Work of American Agricultural Colleges and Experiment Stations:

A. Definite systematic instruction, or formal teaching.
   1. The lecture course, given under the auspices of various clubs and organizations, one night a week for several weeks.
   2. The reading course, drawn up by college and state department of education.
   3. The correspondence course, subjects prescribed and questions set by the college. Answers are sent to the college and returned to the student when corrected.
   4. The movable school, lasting from a week to a month. Instructors are sent from the college; regular lectures and class demonstrations are given as in any school; but the school is itinerant in character.
   5. Permanent demonstration plots or farms. The value of certain methods of soil treatment and the cultivation of varieties of crops are demonstrated right at the door of the farmer.
   6. Club work of various kinds, such as boys' and girls' corn clubs, canning clubs, poultry clubs, and the like.

B. Teaching that is more or less informal, advisory, or suggestive.
   1. Conventions.
      (a) Farmers' institutes. These are conducted by the college in many states. Where they are not conducted by the college, they generally look to the college for assistance.
      (b) Conferences on special topics, such as dairying, poultry raising, fruit growing, and the like.
      (c) Short courses for agricultural instruction.
   2. Itinerant lectures.
      (a) Miscellaneous lectures on call and under many auspices.
      (b) Traveling advisers or field agents.
      (c) The permanently located expert or adviser for a county or other prescribed district.
   3. Literature.
      (a) Publications: monographs, leaflets, circulars, bulletins, etc.
      (b) Correspondence.
      (c) Traveling libraries.
   4. Object lessons.
      (a) Field and platform demonstrations, such as spraying demonstrations, etc.
      (b) Educational exhibits at fairs, stock judging, corn testing, and the like.
      (c) Excursions to the college, to study experiments or to see demonstrations.
      (d) Special trains, railroad cars, or trucks carrying agricultural material for educational purposes.

C. Coördination and coöperation.
   1. Holding "Conference on Rural Progress," to bring together all the people interested in rural life for the discussion of the larger problems of rural betterment.
   2. Coöperation with other agencies and activities, such as chambers of commerce, boards of trade, manufacturers' associations, labor organizations, and the like.

All these are, or should be, educational enterprises designed to reach and benefit every man, woman, and child in every farm community. With the expansion of agricultural education in the high schools, many of these extension activities will be found feasible there. Agricultural instructors in the high schools are becoming wide awake to their opportunities for coöperating with the colleges in bringing to their community the combined services of the high school and the college. At this time, though, we are most directly concerned with the development of the work through the United States Department of Agriculture and the state agricultural colleges.

**The Smith-Lever Extension Act.** The Smith-Lever Extension Act (1914) provides for a permanent nation-wide system of agricultural extension work to be carried on by the state agricultural colleges in coöperation with the United States Department of Agriculture. This extension work includes practical instruction and demonstration in agriculture and home economics and the imparting of information through field demonstrations, publications, and other means, as mutually agreed upon by the secretary of agriculture and the state agricultural colleges.

Under this act, one agricultural college in each state is selected, with the understanding that this college must maintain a division exclusively devoted to extension work in agriculture and home economics. This department is in charge of a director selected by the college, with the approval of the United States Department of Agriculture. The director must submit detailed projects covering each line of extension work, and these must be approved by the Department before the work is undertaken. Under this director, generally there are men in charge of various lines of work. In all states, one state leader has charge of county-agent work and boys' and girls' club work, the agents in charge of club work being subordinate to him; in each of the thirty-three northern and western states, there is a separate state leader for the club work.

**Funds available.** The Smith-Lever Agricultural Extension Act provided that each state should receive $10,000 annually for coöperative extension work in agriculture and home economics, making a total of $480,000 per annum, beginning with the fiscal year 1914–15. For the fiscal year 1915–16 it provided for $600,000 additional to be distributed among the several states in the proportion that the rural population of each state bore to the total population of all the states, as determined by the last census. This amount is to be increased by $500,000 each year until the fiscal year 1922–23, when the total amount reaches $4,580,000. This additional appropriation does not become available to a state until an equal amount has been appropriated by the legislature of that state or has been provided by state, county, college, local, or individual contributions from within the state. The aggregate sums thus required to be provided by the states for the fiscal year 1922–23, and annually thereafter, will be $4,100,000.

The funds are to be used only for the instruction of persons not resident in or attending any of the designated colleges. None of it may be used for the purchase or repair of buildings or the rental of land; nor may more than 5 per cent be applied to the printing or distribution of printed matter. Its agent is the teacher, and its classroom and laboratory the farm.

In addition to the money directly appropriated to offset Federal Smith-Lever funds and available under the provisions of the Smith-Lever Act, considerable sums have been contributed from various sources within the states. The total amount in 1916–17 was $6,103,000, derived from the following sources: $943,000 from the farmers' coöperative demonstration funds, $120,000 from other bureaus and offices of the department, $1,580,000 from Federal Smith-Lever funds, and $1,100,000 from state Smith-Lever funds. Approximately, $600,000 was appropriated by the state legislatures in addition to the money put up as an offset, $1,250,000 from county funds, $140,000 from college funds, and $370,000 from other miscellaneous sources.

**How the money is spent.** The allotment of funds from all sources for coöperative agricultural extension work for the year ending June 30, 1917, by projects, was as follows: Administration, $445,720; publications, $137,187; county agents, $3,102,893; home economics, $756,050; extension schools and boys' and girls' club work, $565,309; animal husbandry, $126,815; poultry, $44,684; dairying, $173,871; animal diseases, $23,345; agronomy, $125,380; horticulture, $82,490; botany and plant pathology, $35,139; entomology, apiculture, and ornithology, $13,485; forestry, $3,700; agricultural engineering, $52,281; farm management, $97,155; rural organization, $34,082; marketing, $35,356; exhibits and fairs, $7,775; farmers' institutes, $72,420; correspondence courses, $38,713; agriculture in schools, $15,256; miscellaneous, $113,429; total, $6,102,765.

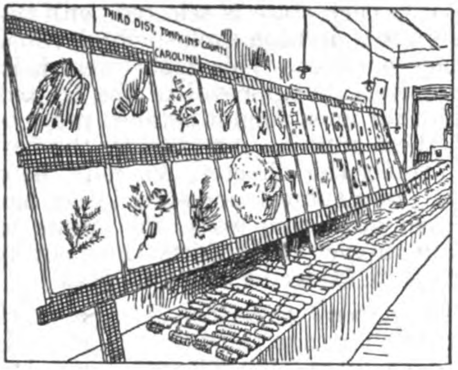



FIG. 246. Competition among schools at fairs and expositions develops healthful rivalry and local pride and puts a premium on teamwork and coöperation among the pupils of each competing institution.

**County agents.** It will be seen that by far the largest amount in the foregoing expenditures went for county-agent work. The county agent is the joint representative of the local community, the state (through its agricultural college), and the nation (through its department of agriculture). The county-agent work really grew out of the farm demonstrations conducted under the direction of agents covering a large territory. About the year 1906, many counties began to contribute to the salary of the agents of the department; and in this way the work became more intensive, being in many cases confined to a single county. Prior to the year 1912, almost all of the extension work in this territory was carried on in the southern states. However, a few states farther north had joined in the movement.

The great practical value of farmers' coöperative demonstration work, as conducted in the South, was shown after 1902, when the Mexican boll weevil appeared in central Texas and destroyed extensive crop areas. The Bureau of Plant Industry tried to convince the cotton growers that they could grow cotton despite the boll weevil, but most of them were not interested in anything except the destruction of the pest. Dr. Seaman A. Knapp, a representative of the United States Department of Agriculture, who was engaged in demonstration work in the South, then arranged with a successful farmer in each county to demonstrate the possibility of growing cotton according to the instructions of the Bureau of Plant Industry without exterminating the boll weevil. These farmers were called "demonstrators." Other farmers, known as "coöperators," were supplied with literature on the subject, were free to call upon the agent, and, in some cases, were occasionally visited by him, but not as frequently as were the demonstrators. The diversification of crops was also encouraged. The result upon the agricultural life of the South was most helpful. Louisiana, Texas, and Arkansas—the boll-weevil states—were not only able to grow cotton, but they engaged in a more diversified agriculture, including the growing of profitable crops of corn and vegetables and the raising of chickens, hogs, and cattle.

County agents are employed coöperatively by the county, the state agricultural college, and the United States Department of Agriculture, assisted in some cases by other coöperating parties. Details as to employment, in so far as the state is concerned, are not the same in all states. In Illinois, for instance, the farmers of any county may organize a farm bureau with a membership of 300 or more, each member paying a fee of from $5 to $10. They then employ a county agent, the government supplementing the fund, usually to the extent of $1,200. In Missouri, the county, the state, and the Federal Government each contributes one third toward the employment of a county agent. However, in one county in Missouri, 150 farmers clubbed together, in 1917, for the employment of a farm agent, whose salary of $5,600 per year they pay without county, state, or national aid. In the whole of the United States, nearly 1,300 male county agents are employed, and there are nearly 500 counties having women agents.

**What the county agent does.** One of the duties of the county agent is to bring to the farmers of his county on their own farms the results of scientific investigations in agriculture and the experience of successful farmers, and, through demonstrations, to induce the local farmers to put these into practice. In his organization work, he assists in reorganizing and redirecting the agriculture of the community, and aids all economic and social forces working for the improvement of agriculture and of country life. He gives instruction not only in those subjects which are generally recognized under the head of improved agricultural practices, but also in farm management, marketing, and the purchasing of supplies. In all this work he conducts a large number of demonstrations and gives out much valuable information. He works, as far as possible, with existing organizations, such as granges, farmers' unions, alliances, organized farmers' institutes, and community clubs; but he may also aid in forming new organizations especially suited to support his work.

In the South, great emphasis is laid upon community organizations of farmers. These are increasing rapidly, and involve work both among men and among women. The tendency and general policy of the work in most of the states in that territory is gradually to form central county organizations composed of representatives of the community organizations, to deal, in coöperation with the

county agents, with such problems as are county-wide in their nature.

In some of the northern and western states, county organizations, called "farm bureaus," have been developed to support the county agents in their work. The farm bureau may include in its membership any person who is interested in better farming. Its officers are generally selected annually. It has an executive committee, which has the responsibility of arranging for the selection and financing of the county agent; and its committees, both central and local, assist the county agent in carrying out the county program of work.

## Boys' and Girls' Extension Work

(*By* O. H. Benson, *of the U. S. Department of Agriculture, who has charge of the work in the thirty-three northern and western states.*)

Farming and home making constitute the two greatest factors back of America's industrial and business efficiency. Upon these two prime and important interests the U. S. Department of Agriculture, coöperating with the state colleges of agriculture, has established a type of popular education truly American in its ideals, as well as in methods of procedure. This promises much for a more efficient and contented rural people, and as a type of education contemplates the connecting of the work of schools, colleges, and universities with the everyday activities of farm and home.

The making of a real democracy requires more than the educating of the people who attend schools and universities. Through extension schools and by means of itinerant teachers information from classroom, laboratory, and experiment station, as well as from books, must be carried to others. This is accomplished by means of personal visits, field meetings, demonstrations, printed follow-up instructions, and by other methods which will give to every home the correct interpretation of useful knowledge and help average citizens everywhere to make of it common practice.

**History of the movement.** Boys' and Girls' Extension Work was first known in the Central States in connection with county and state industrial fairs. Some of the county superintendents of schools of Iowa, Illinois, Missouri, Indiana, and Ohio as early as 1896 conducted boys' and girls' contests and exhibits in the production and showing of farm animals and products. These activities were later developed into the garden and corn-growing contests. These early activities and the efforts by volunteer leaders met with considerable discouragement. Due to a lack of trained leadership and to failure of a full appreciation by the public as to the real purpose of the work, projects of this type were encouraged spasmodically and only as a temporary enterprise for the purpose of interesting the children in the less permanent phases of farm and home life.

The Federal Department of Agriculture took up the project as a definite means for the improvement of southern agriculture in 1908. Its first efforts were devoted to activities in a very limited territory. In the year 1912 the movement was projected into the North and West. Later, by the enactment into law of the Smith-Lever Bill the work was quickly and effectually spread throughout the Union. As a result, national, state, district, and county club leaders and extension specialists, together with county agricultural agents and home demonstrators, are in evidence everywhere and are well organized, definitely working out a program for the improvememt of American agriculture and home life. A great deal of Federal and state money is being spent each year for the improvement of the farms and homes through our boys and girls. In the year 1916, it cost 79 cents per capita for the year to supervise, direct, and handle this type of work in the 33 northern and western states, and this includes the total investment of local, state, and Federal funds.

For this investment, the boys and girls produced food products valued at $20.96 per capita, thus showing a profit on the investment of $20.17 for each club member. This economical value is, of course, by far the lowest measure we can give to a constructive educational project. In the year 1917, it cost 63 cents per capita to do the work; as a result the boys and girls produced a per capita food supply of $22.70, and by so doing created for themselves and the nation a fundamental basis for war time thrift.

**Types of work undertaken.** The most important work undertaken in every state in the Union is known as the Boys' and Girls' Club Work. This simply means that every club member who signs up for any given farm or home project for a year, or given period, agrees to participate in all the activities of the club group under the direction of a club leader. This he or she must do in addition to the regular work of his or her project, such as the growing of a garden, raising of farm crops, feeding

Fig. 247. It is the little efficiency details that count in economical canning. Club work enables children to learn these methods and facts—by using them in actual cases.

of farm animals, or in the carrying on of a definite program of canning, cooking, bread baking, garment making, or home management.

The club program outlines the work of a project for the club group covering a season, a year, or even a series of four years, and including a crop-rotation plan. Club members keep their own records of crops, receipts, and observations, follow carefully all instructions and directions, attend field meetings, demonstrations, club festivals, and contests. As a result of their own or collective achievements they are often honored at banquets, achievement-day programs, and by invitations to go on educational trips to state capitals and to Washington, D. C., where they become guests of the first citizens of the state or U. S. government.

In connection with the local, state, and county club work, leaders often conduct special programs for the purpose of follow-up work and reinforcement, such as boys' and girls' institutes, midsummer camps, boys' and girls' club fairs and festivals, boys' and girls' short courses, and movable schools.

In addition to this, most of the meetings held for adults, such as farmers' institutes, agricultural meetings, and other similar occasions, have provided for a Junior Department, having a special committee in charge of the boys' and girls' section. Through this committee and the adult leader the direction of the work is made more effective. Practically all of the local, county, district and state leaders have arrangements at state fairs for junior exhibit divisions. Not only has this made the boys' and girls' work popular and more definitely appreciated by the general public, but it has proved a pleasing addition to the fairs and increased their attendance and educational value. Through these exhibits thousands of boys and girls in every state have learned what is meant by a pure strain of seed, purebred stock, egg-laying strains of poultry, and market standards and quality of food products; and thus there has been worked out for the soil and the barnyards higher standards for grain, crops, and livestock. So the boys and girls have come back the next year to demonstrate that they, too, know how to produce high-grade products and animals.

**Club work an American type of education.** Boys' and girls' club work is an organized system of extension teaching for young people in agriculture and home economics, and is usually conducted by means of group meetings, home work in agriculture, home economics and related enterprises. In connection with this work practical demonstrations are conducted, first by leaders, then by club members, for the purpose of illustrating the good practices for the farm and the home. Club work contemplates the organization of young people into groups, in order that the members may reinforce one another and that leaders may more effectively deal with the members in their home projects. In addition to following the instructions for the carrying out of the project on the farm or in the home, members also agree to follow the instructions with reference to their club programs. This type of education has been truly called the "made-in-America education" and is one of the most efficient agencies for the interpretation of the theory of classroom, textbook, and laboratory in the terms of actual practice on the farm and in the home. As an agency for the bringing about of a closer relation between the school and home it has no superior. It is responsible for the giving of proper guidance to teachers and leaders in the best methods of approaching the home and of getting into the life of the child by means of personal visits to the back yard and to the kitchen. It represents a back-yard and back-door entry to the home rather than the front-door and parlor entry. When educators have thus learned how to approach the home through the avenue of practical projects it becomes natural for them to give motive to the interests and studies of the child at school, and to seek the whole-hearted coöperation of parents and friends at home.

## The Corn that Won the Championship

**This is the corn that won the championship.**

**This is the boy that raised the corn that won the championship.**

**This is the neighbor all forlorn, who, whenever he waked in the early morn, could hear the rustling of the corn, agrowing away, getting taller each day, on the opposite farm across the way, where lived the boy that raised the corn that won the championship.**

**This is the way the boy replies—"To raise such corn, just fertilize—and plant good seed and tend it well," in fact that's all there is to tell, to the man that wanted to know, how the boy could make such large yields grow,—thrice as much as the neighbor all forlorn, who, whenever he waked in the early morn, could hear the rustling of the corn, agrowing away, getting taller each day, on the opposite farm, across the way, where lived the boy that raised the corn that won the championship.**

—MEL RYDER

**Home economics.** The importance of providing special extension work for the women and girls on the farm has been recognized. The result is the employment of women county agents or home-demonstration agents. The woman agent organizes clubs of women, gives them instruction, conducts demonstrations, and superintends the putting of the lessons into practice in the homes. Among the problems now being taken up are children's welfare, the selection, preservation, and preparation of food, the canning of fruit and vegetables on the farm, the selection and protection of water supply, sewage disposal, house ventilation, household equipment and management, the use of labor-saving devices and machinery, and the control of insects and other pests.

**Work of specialists.** Both the state agricultural college and the United States Department of Agriculture employ specialists in agriculture and home economics. These workers aid the county leaders, and also give instruction to farmers in counties where there are no agents. The principal lines of extension work of this character conducted in the Department of Agriculture, through the Bureau of Animal Industry, are hog-cholera work, pig and poultry clubs, dairying, and animal husbandry.

In hog-cholera work, veterinary field agents have been appointed to coöperate with county leaders and to demonstrate to them and to local veterinarians and farmers the prevention of loss from hog cholera and of the spread of the disease from herd to herd by the use of the serum treatment and by proper quarantine and sanitation of premises.

In dairy extension work, specialists are appointed to conduct work in the various states, through county leaders and otherwise, by organizing cow-testing and bull associations, teaching the keeping of herd records, planning the construction of silos and the remodeling of dairy barns, milkhouses, and other dairy buildings, establishing feeding demonstrations, and instructing in the management of herds and in the solving of other special dairy-farm problems.

In soils, forestry, plant pathology, marketing, and rural organization, also, specialists are employed to carry on extension work.

**Extension schools and farmers' institutes.** Courses of instruction, accompanied by demonstrations, illustrated lectures, and exhibits, organized and conducted by specialists attached to the agricultural colleges, are given in different localities. These courses usually extend over 5 or 6 days.

The late Joe Wing once said that the first farmers' institute was held when two farmers, working in adjoining fields, leaned over the fence and talked to each other. Certain it is that the farmers' institute represents one of the oldest and best known forms of extension work. As has been well said, "Modern extension service of the agricultural colleges had for its mother the university extension idea and for its father the farmers' institute." Farmers' institutes, as we now know them, had their beginning informally some 50 years ago, when farmers all over the country, aware that the soil was becoming less productive, gathered together to discuss ways and means of improving farm methods. As the state experiment stations developed, and won the confidence of practical men, the research workers from the colleges were asked to meet with the farmers.

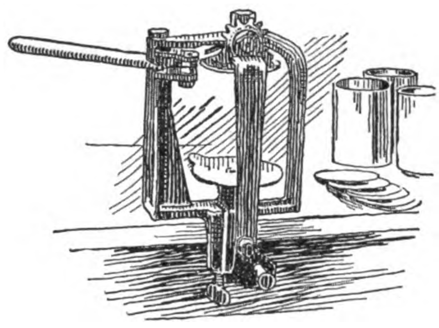


FIG. 248. A small hand sealer for No. 2 cans suitable for both home use and the needs of a small canning club

In 1896, there was formed what is known as the American Association of Farmers' Institute Workers, as an expression of the belief that "the farmers' institutes of each state and province (of Canada) should be guided by some central authority which recognizes the agricultural college and experiment station as the leaders of our system of agricultural education, and the farmers' institutes as a strong, active, and effective ally."

**Farmers' institute specialist.** The usefulness of the institutes, supported by state appropriations, and often conducted by state boards of agriculture, became so evident that Congress, in 1903, provided for a farmers' institute specialist in the Office of Experiment Stations. His duties were to investigate and assist institute work and to make known in a practical way what was being done by the Department of Agriculture. John Hamilton, then secretary of agriculture for Pennsylvania, was appointed to the office. In Bulletin 241 (1911) of the Office of Experiment Stations Mr. Hamilton said: "An examination of the institute laws of the several states reveals the fact that, while they differ in their form and requirements, as well as in the authority they confer and the amount of money they appropriate, yet they are one in purpose to aid farming people by affording them opportunity to secure the latest and most reliable information relating to agriculture and to receive definite information through a living teacher."

**The Chautauqua system.** The Chautauqua

system is an effective educational force. During its season of 1916, it held over 3,000 assemblies which reached about 5,000,000 people. While most Chautauqua gatherings are held in villages and towns, so great has become the importance of agriculture that it is customary to devote a day to subjects that are, first of all, of interest to farmer folk. Where this is not done, the program for the week (Chautauqua assemblies average about this period) almost always includes at least one address on agriculture. In this work, the great difficulty has been to get speakers and demonstrators who not only know agriculture, but who are able to present the subject in a pleasing and entertaining manner. In various places, notably in the Central West, the farmers' Chautauqua assembly is becoming quite common. In these gatherings, practically all the addresses and demonstrations have to do with agriculture. Only enough musical and other strictly entertainment features are added to lighten up the program, and, where possible, some home talent is used. The attendance at such meetings has been large and the benefits far-reaching.

**Other extension work.** Many other kinds of agricultural extension work are being carried on. For example, special trains carry lecturers and illustrative material (often including livestock and grain) and attract thousands of visitors. In contrast with these sometimes spectacular methods are the home reading and correspondence study courses. This method has rapidly won the confidence of the public, and is yearly adding to the thousands of people who are reached and helped. In a number of states, teachers' extension courses are offered. The publications of the United States Department of Agriculture represent one of the most generally used and most valuable forms of agricultural extension work. During the year ending June 30, 1915, the Department mailed 26,386,661 copies of its publications.

The situation as regards agricultural extension may be summarized as follows:

1. There is a desire on the part of the American farmer to improve himself in his vocation. This desire seems keenest between the ages of 20 and 30. It is not clearly defined, but awaits the definition by an outside agency.
2. The states need extension service in agriculture.
3. The main aims of extension service are: to (a) give technical information; (b) give inspiration, create a proper mental attitude, etc.; (c) give general education; (d) discuss the applicable values of new discoveries.
4. Agricultural extension work is most efficiently done through the following agencies: (a) agricultural colleges; (b) the United States Department of Agriculture; (c) secondary schools; (d) a few commercial concerns; (e) the agricultural press; (f) state normal schools; (g) the elementary school.
5. Demonstration of scientific methods on a farmer's own farm, he himself doing the work in coöperation with an agent or institution, is the most effective form of extension service. The tendency is toward less teaching and more of other forms of extension work.
6. One of the most promising forms of extension service is the county farm bureau, or county-leadership movement. Where the farmers' organization provides for the expenditure of adequate sums of money, and where a paid agent of expert caliber directs this organization, the farmers may hope to come into their proper relations as business men of the country, and to bring to themselves all that education, science, and society have achieved for the development of the people.

# SOME THINGS WORTH LEARNING IN SCHOOL

*By* ELLA VICTORIA DOBBS, *Chairman, National Council of Primary Education; and member of the Faculty of the University of Missouri; Vice-president, Missouri Congress of Mothers, and Parent-Teacher Associations. She has taught in rural communities in Nebraska, Illinois, Utah, Montana and California, being especially interested in manual training, on which she is the author of two text books. No worker can do his best or obtain the best in life if he shuts himself up within one narrow circle of interests. Modern knowledge must be broad as well as deep; and to make it so the farm boy and girl must study other things than crops, soils, animals, and their management. In this way they will not only improve themselves and their normal opportunities, but also fit themselves for emergency work which, when required at all, is of vital importance. As an illustration, since these chapters were blocked out, the subject of "first aid" has received new and increased attention, even to the extent of being incorporated among the subjects taught in a number of schools. The whole problem is one of making boys and girls more fit to take their places and play their parts in life.*—EDITOR.

ONE prominent educator, in outlining a "well-balanced ration" in education, asserts that the aim of education is fourfold and that, in planning a course of study, the child's needs must be considered as follows:

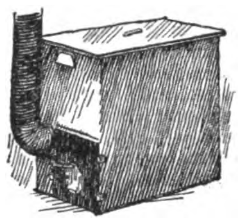


FIG. 249. A good water-bath canning outfit for community or club work.

*First,* physical education, because the greatest need is for a strong, healthy body. Unless one has health, it is impossible to be fully efficient, no matter how fine a mind one may have or how extensive may be one's education.

*Second,* vocational education, or learning how to earn a living. Everyone needs to be able to maintain himself.

*Third,* social education. Since we must live with other people, it is important that we learn how to live with them not only peacefully, but happily and helpfully.

*Fourth,* cultural education, which means learning how to make the most of ourselves and to get the best out of life.

Let us examine each of these four phases or fields of education and see what subjects the children should study, what things they should learn, and how they should apply them to their daily lives, in order to gain these fourfold advantages from their schooling.

## Physical Education

**A sound body.** Everyone agrees that a strong, sound body is the greatest blessing in life. Sickly people have spent fortunes in the attempt to gain health. Quack doctors and get-rich-quick deceivers have made fortunes by offering fake cures for all sorts of physical ailments. A generation or so ago, it was supposed to be a mark of refinement and culture to be "delicate," and stories always described the rich heroine as frail and tender. In a fairy story, a lost princess was proved to be a true princess because she was uncomfortably conscious of the three peas put in her bed, although five feather beds were between those peas and her sensitive flesh.

But times have changed, and we have learned that the poor health of rich people is most frequently due to too much rich food and too little exercise. Instead of being a mark of gentility, delicate health is often an evidence of laziness and gluttony, a cause for shame, not pride. We have learned also that many of the ills that beset the bodies of both rich and poor are not visitations of Providence, but are the direct result of incorrect habits of living. These, in turn, are very often the result of ignorance, superstition or personal carelessness.

The terrible "white plague" of tuberculosis, or consumption, which causes the death of thousands every year, is due chiefly to breathing bad air, and may sometimes be cured if taken in time by fresh air and wholesome food. Numbers of diseases are due directly to improper habits in eating, which interfere with the processes of digestion and elimination and fill the blood with poisons instead of food. Every day these facts are becoming more clearly established and proved beyond the question of a doubt. Every day it is becoming more and more a disgrace to be sick and weak, because, in so many instances, it is a confession that one is willfully careless of the laws of health.

If these things are true, and they are very true, then it follows that the school and the home must combine to teach children how to live properly, how to develop strong bodies, and how to keep them strong.

This study is especially important in rural schools because, being farther away from the centers of population, there is less opportunity to learn through contact with other people, and more danger of bad habits persisting from generation to generation.

What studies will help most in the development of a sound body? First are hygiene and the elements of physiology. A study which merely counts the bones, names the muscles, and locates the vital organs is of little help. The study must teach how the machinery of the body operates and how it must be cared for. It must establish the idea that it is infinitely more important to care for the human machine properly than to give all the care to the automobile or threshing machine. New machines are being turned out by factories every day; but one sound body is all that each of us can hope for to carry us all through life.

**The teeth.** It must teach not merely that good teeth are a matter of good looks, but that bad teeth are frequently the cause of bad health: first, because with poor teeth it is impossible to chew the food properly, digestion is interfered with, and a long train of evils set to work; second, because the bad teeth are actually rotting, filling the blood with all sorts of poisons, which are likely to cause all sorts of trouble, such as defective eyesight and hearing. A striking example is furnished in the case of a little girl who had had trouble with an ulcerated tooth. Finally, the tooth was drawn. Soon after, she was able to see without the glasses she had formerly been

obliged to wear if necessary. The diseased tooth had affected also the nerves of the eye.

**Fresh air.** Through the study of hygiene is learned the importance of fresh air in the house, both night and day. Many country residents think, because they work out of doors all day, that they get enough fresh air without open windows at night.

**Exercise.** It is necessary to take regular exercise which uses all the muscles. Some country folks object to any attempt at athletic games, or other organized physical exercise, on the ground that the children get enough exercise in walking to and from school and in the farm work they must do at home. Organized physical exercise, however, can do what chores can never do, namely, train one to correct habits of standing and walking and a symmetrical development of all parts of the body instead of a one-sided strain on certain sets of muscles.

Slouchy, awkward habits of standing and walking are frequently accompanied by similar habits of thinking. The man who stands with his feet wide apart and his hands in his pockets, while he rolls his tobacco from one side of his mouth to the other, may sometimes be a successful farmer, but generally he is not.

**Necessity for proper food.** The development of a sound body entails not only good habits, based on sound knowledge of how the bodily machinery works, but also good quality in the food which is to nourish it. What to eat and how to cook it are problems of too serious importance to be left to the chance teaching of untrained mothers. Knowing how to cook tasty, appetizing dishes does not always insure knowing how to choose right combinations of wholesome food. In fact, a reputation as a "good cook" tempts many a mother to injure the health of her family by serving too much rich food; and then, because of her ignorance of food values—the values of different kinds of food in building up the body—she bewails the fate which makes the members of her family "delicate."

Certain foods serve to build bone; others make muscle; still others give heat. It is important to know the food value of at least the common articles of food. Cooking changes the nature of most foods. It is necessary to know which foods are most valuable raw, and which others need to be cooked, and how much cooking each needs. Some foods contain acids and other elements which produce harmful results, when combined in certain ways. It is important to know what these elements are, so that only good combinations may be made. Each meal should be planned to supply the right proportion of bone-, muscle-, and strength-giving food. Foods which produce heat are needed in greater proportion in winter than in summer. Children need different food from that suitable for grown-ups. The farmer, who does hard muscular work in the open air, needs different food from that best suited to a man who sits all day at work which taxes his brain and nerves only.

**Why we need to study food values in school.** Many of these facts are never mentioned in the home. Indeed, many mothers do not know anything about food values, though they resent the idea of cooking as a school subject, because "the children can learn to cook at home." Many so-called good cooks only know how to give their cooking a good taste and cannot teach their children food values. Therefore, the school must do these things, or we shall go on blundering over the same mistakes.

**Clothing.** Next to fresh air, wholesome food, and proper exercise, suitable and comfortable clothing plays an important part in the development of a sound body. Badly shaped shoes and tight clothing are our worse faults in this field. Fashion dictates what we shall wear, and people who have something to sell often set the fashions. It is to the advantage of the merchant to make us want new clothing. If he changes the fashions often, we will buy more. We need to know what is good for us, so that we may buy only what we need. We need to know enough about materials to tell cheap imitations from good goods, or we are likely to waste our money. We need to know enough about colors and patterns to choose becoming garments, because strangers often judge us first by our clothes. It is hard to live down our clothes, too, if they are badly chosen. One forms very different opinions about the characters of two girls, if one wears modest colors and comfortable common-sense shoes and the other, flashy colors, cheap jewelry, and silly high-heeled shoes which are too tight for her.

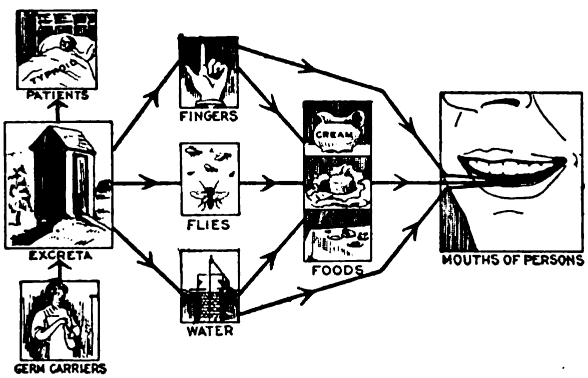
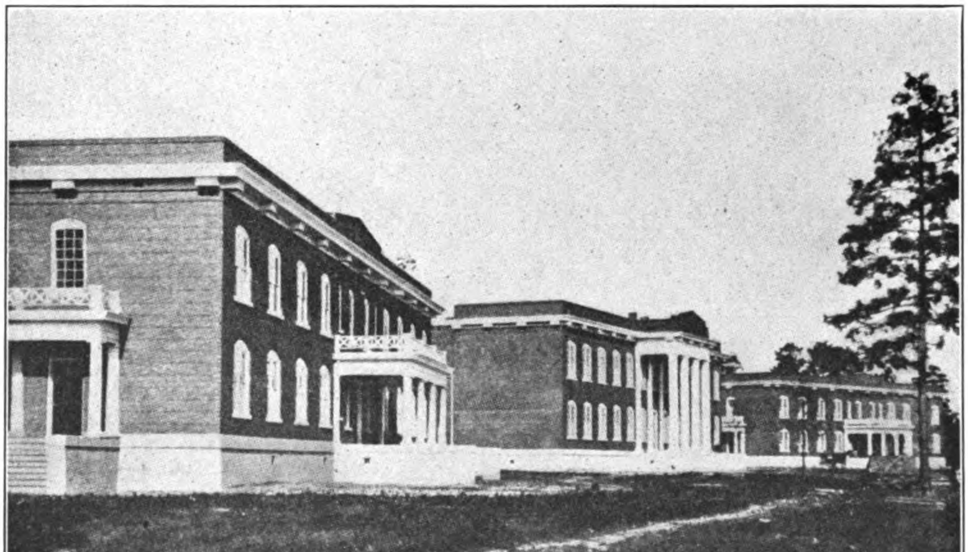



FIG. 250. Everyone should know the ways in which typhoid fever and other diseases are carried, so that they may avoid them. (U. S. Public Health Service.)

**A typical one-room rural school almost hidden by the tent used each year by its pupils for club meetings, festivals, exhibits, and other activities**



**Buildings of the Second District Agricultural School of Tifton, Georgia, a typical modern source of knowledge.** (U. S. Department of Agriculture)

**AGRICULTURAL EDUCATION HAS NOT ONLY GROWN AND BEEN IMPROVED, BUT ALSO HAS EXTENDED ITS RANGE OF SUCCESSFUL APPLICATION THROUGHOUT ALL THE COUNTRY**

A Few of the Buildings of the New York State College of Agriculture at Cornell University. The Agricultural College Has Been Developed to a Degree of Service and Efficiency Rarely if Ever Before Attained by Institutions of Learning

Clothing should express what we are. Knowing how to dress tastefully is one of the things everyone needs to learn.

**Sanitation.** Sanitation is a term which means keeping absolutely clean. Keeping clean means more than merely washing, even though a plentiful supply of hot water and soap is used. It means freedom from harmful germs, which are too small to be seen, but which cause much disease and waste.

**Flies.** Flies are responsible for a great deal of disease. Even a few flies may bring to an otherwise clean home germs which may cost the life of a member of the family. Typhoid fever and tuberculosis are examples of diseases caused by germs which are carried by flies, mosquitoes, and other insect pests.

**Drinking water.** Germs may also be carried through the earth to the well from which the drinking water comes. Some people throw dish water and other slops away where the water can sink into the ground, carrying germs with it into the family well. The location of the well in relation to cesspools and vaults is of the greatest importance. It is important to learn where to put them.

**Promiscuous use of cup, towels, etc.** Common drinking cups, towels, combs, and other articles of personal use, when used by numerous persons, are often responsible for the spread of diseases more or less serious, such as colds, skin diseases, typhoid fever, and tuberculosis. This applies to family utensils as well as to public cups, combs, etc. Many diseases which "run through a family" may be traced to the unsanitary use of "the family dipper," "the family comb," the roller towel and similar articles.

**Sanitation must be taught in school.** It is important that school work include lessons in keeping clean. Science is making new discoveries constantly as to the causes of disease and concerning forms of waste. It is necessary to teach these things in school, because all parents do not have opportunity to keep up with what is going on. New books are needed, because the old books used by various members of the family are frequently out of date. Old books are often dusty and dirty, also, and are likely to be carriers of disease.

**Preventive measures.** Health is our most precious possession. Cleanliness is important in maintaining health. No wideawake farmer can afford to be ignorant concerning the treatment of hog-cholera, for example, or of tuberculosis in cattle, or of any other diseases which are liable to destroy his year's profits and more.

Fig. 251. The use of the individual drinking cup should be taught and practised both at home and in school.

It is at least as important that we study the cause and prevention of the preventable diseases which attack members of the family. Thousands of babies die during their first year. Most of them die because of ignorance or carelessness on the part of those who care for them.

Every school should teach the known facts regarding common diseases which may be avoided by proper attention to sanitary conditions; every school should teach methods of preventing the spread of contagious diseases; and every school should teach something of the care of little children, in order that, later on, the boys and girls may become intelligent, capable fathers and mothers.

**Vital secrets.** No course of instruction on the care of the body is complete if it does not give the children the fundamental truths about the laws of human reproduction. It is a sad fact that knowledge of this most important and most sacred function is not only left to chance, but is surrounded, in many instances, with vulgar ideas. Right teaching on this subject is especially needed in the country, where children early learn the physical facts from observation of animals. Unless right teaching establishes higher ideals, the children will associate every thought of reproduction with coarse, animal connections, and will know nothing of its sacred responsibilities. Nature has made children curious on this subject. If we do not give them the information in a right way, they will get it in a wrong way. We owe it to them to satisfy their curiosity with pure thoughts and to teach them how to keep their bodies and minds pure.

## Vocational Education, or Learning to Earn

To be able to earn a comfortable living requires at least fair skill in at least one kind of work.

A few years ago, a great deal of fun was poked at the "book farmers." In some quarters, there are still to be found people who do not understand the value of scientific knowledge and who think they can guess at the way to do their work, and get along well enough. But those who have tried and proved it know that it saves time and saves money to *know how to do one's work without making mistakes.* Mistakes are the most expensive things we pay for.

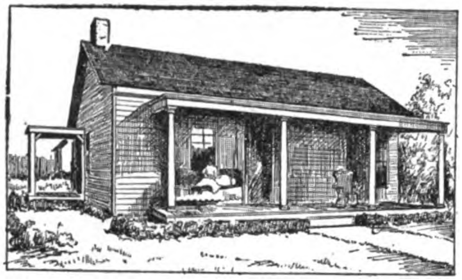


FIG. 252. A neat, comfortable teachers' cottage. Only amid congenial surroundings can a teacher do her best and take a real interest in her work. (See p. 306.)

**It pays to know how.** Science is often thought of as a high-school or college subject; but there are many scientific facts which may be taught in the lower grades and which are of great value to the farmer. Children can learn a great deal about the growth of plants and animals; about the best way to cultivate and raise them; about the diseases which attack them and how to cure them; about the pests which beset them and how to get rid of them. They can learn much about soils and fertilizers. They can learn how to collect and test seeds. They can gain some real experience of a definite sort by working with small plots, either on the school grounds or at home.

In such work, they learn how to do with a small quantity, and lessen the chance of making mistakes with large quantities later. They also have the benefit of working under careful direction. Not only is this sort of study helpful, but it adds to the interest of school work; and children are more willing to stay in school till they have learned enough to make a success of their lives.

**Employ a good teacher.** Of course, if the children are to get this knowledge in school, a teacher must be employed who can teach it. If the community employs a cheap teacher who cannot teach these subjects which mean so much in the success of work out of school, the children are likely to get tired of school and to want to go to work before they are prepared to earn a good living. Because the children are ignorant of the real causes, they will blame the weather for their poor crops, when it is the fault of poor fertilizer, or poor seed or some other thing which might have been controlled had they only known how. *It pays to know how.*

Besides learning scientific facts about the growth of plants and animals, it is necessary to learn business methods of management. Some of the foregoing chapters have put emphasis upon the value of systematic methods and upon the great loss in time and money which comes through lack of system. Much that is essential to success in farming may be learned in the early school years, if the teacher knows how to teach the children to form systematic habits. It will save money in the end to pay more to a good teacher who knows how. It is a waste of money to pay anything to a poor teacher who permits the children to form bad habits.

To read and write and count are necessary tools of learning which the school must teach the child to use. The important thing is the use he makes of these tools. Knowing how to read will be of little value, if he does not know what to read. Even reading good books will be of slight advantage unless there goes with it a habit of putting ideas into practice.

If the children are to be taught to take care of themselves successfully, they must begin early, both at home and in school, to carry responsibility, first for small things, next for larger things. They must learn to think things out to the end before setting to work. They must learn to stick to a job until it is finished. They must learn how to choose the best methods by which to do the work. No amount of ability to remember dates or to bound states or to work long problems in fractions will take the place of this knowledge.

These habits can be cultivated in school, first in the plays and games of the little folks, later in small projects which the older children can carry out.

Though these projects sometimes seem like play, they are planned to develop the good qualities listed above. Patrons often hinder the work of the school by objecting to any form of school activity which is different from the way things were done in their own school days. They forget that school methods, like farming methods, are improving all the time.

**Manual arts.** Various kinds of handwork are useful in helping to form the habits specified above. In handwork projects, it is necessary to plan things out before setting to work. Otherwise, the work is likely to be a failure. If the worker does not stick to his job till it is finished, the unfinished work is there to accuse him. He cannot forget it as he can an unlearned spelling lesson. It is easy to see the advantage of using right methods of work when skill brings a better result. Besides training in good habits, lessons in handwork should teach the children how to do many useful things needed both on the farm and in the town. The children should learn to do many things which, later on, save the expense of calling in a carpenter or a blacksmith.

Every boy and every girl should know how to do some useful work well enough to earn a living by it. It is as important for the girls as for the boys to be prepared for their part in life's work. It is not easy to measure the money value of knowing how to cook the right sort of food well or to take proper care of a family of children. It is easy to measure the cost of ignorance, when doctors' bills must be paid. It is impossible to put a money value on the comfort that comes from knowing how to keep the household machinery working smoothly, yet much of our health and happiness depends upon these things. They are too precious to be left to chance. They are too important to be learned only by the few who have capable mothers, while the rest miss them altogether. Girls as well as boys *should know how to do their work in the best way.*

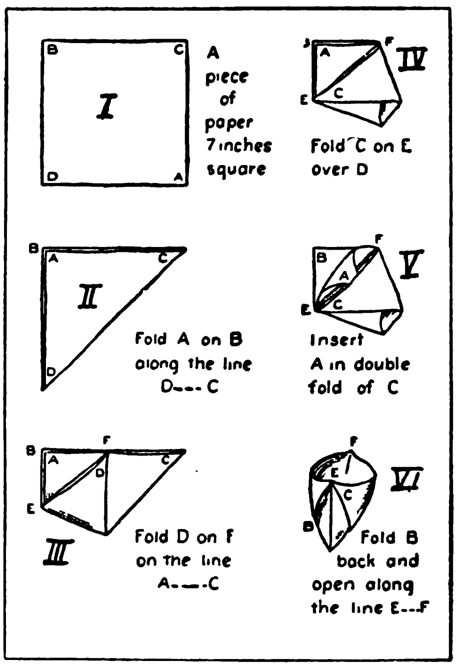



FIG. 253. Six steps in making a sanitary, paper drinking-cup. Every child should know how to do it. (Cornell Reading Course.)

## Social Education

Social education includes everything that will help a community to be neighborly and to pull together. Every farmer knows how hard it is to move a heavy load with a team which will not pull together. Every preacher knows how impossible it is to accomplish good work in a community which is made up of factions which will not pull together. Every teacher knows how hard it is to teach school in a neighborhood where the people are divided into groups which pull against each other.

Success in football and many other games depends on team work. In all community life, also, team work is necessary. Team work means that all members of the team must work for the same thing at the same time and pull in the same direction. Failure in all community work comes when some

of the members refuse to work unless they can work as they please and when they please, or unless they can "boss everything."

Children in school need to learn to work together as well as to work independently. It is necessary sometimes for each one to sit in his own seat with his own books and papers, and work out his own problems or write his own essays all alone, in order that he may learn to depend upon himself. It is just as important that at other times he shall do his share in a large undertaking. He must learn how to give up his personal wishes when another way is preferred by the group. In a democracy, the majority must rule. The serious opinion of thoughtful people generally places a majority on the right side. The boy must learn to do hard or disagreeable work for the good of the group, even though he gets nothing out of it himself except the satisfaction of having done his duty.

**Club work.** Club work of various sorts, athletic teams, school festivals, and pageants, group plays and games all help in this necessary development of the social side of life. These enterprises help in two ways at once: (1) in athletic sports, strong bodies are developed while the children are learning team work; (2) clubs in cooking, sewing, canning, corn growing, stock judging, debating, and in other fields all help the children to gain a great deal of practical knowledge, while they are learning to work together to make a good record for their school.

School festivals and pageants stimulate a strong community feeling by centering the thought of the entire community on one purpose. The same spirit which, in school days, helps to make a success of the school play will, in later years, work for good roads and a better schoolhouse.

These social activities are important, also, in making country life attractive. Boys and girls soon discover that there is always something going on in the city. Country life must be made equally attractive, if children are to be kept on the farm and saved from some of the evils of the town.

All young animals play. We were all intended to be happy. Children will find a way to be happy if they can. If we do not provide wholesome fun, they are likely to find the other kind. School life should teach right ways of having a good time, and train people to work together for the community good.

## Cultural Education—Learning to make the Most of Ourselves

Cultural development, as stated above, means both making the most of one's capacities and getting the most out of life. "Eyes have they and they see not; ears have they and they hear not" is just as true to-day as when spoken hundreds of years ago.

One person walks along a country road and tramples a wayside flower without seeing it. Another person, whose eyes are open and whose mind is alert because he *knows*, sees not only that wayside flower, but thinks about thousands more of its family, scattered over the earth; knows the value of its root or of its leaves in medicine; sees its cultivated cousins blooming in stately gardens; knows the lines a poet has written about it, or a part it has played in history. One person kicks aside a pebble in his path. Another picks it up and reads in its form and color the world's history; reads of glaciers and earthquakes, of floods and volcanic fires. One person looks at a horse and sees just a beast of burden. Another looks at the same horse and sees the qualities of its ancestors for generations. And what makes the difference? One knows the secrets of botany, geology, and biology; to the other this knowledge is a sealed book.

FIG. 254. The joy and value of nature study

Things are going on about us all the time which are more interesting than novels, more thrilling than moving-picture shows; but we are often blind to them because we do not know they are there. Life is never dull to people who really see and hear what is going on. The student of human nature reads the differences in people as the

stockman reads animals or the geologist reads stones. People show what they think about, in their faces, their manners, their walk, and their clothes quite as much as in what they say.

**The three R's not enough.** Some people (farm folk among them) think that the "three R's" are enough to learn in school. Enough "readin" to get the news from a daily paper, enough "ritin" to send a letter to the boy in town, and enough "rithmetic" to figure up one's savings, may make it possible to get along, even in these days when learning counts; but it does not make it possible to get the best out of life.

In thinking of the things which children should learn in school, both parents and teachers need to remember *why* they should be taught. A study of books which tell of the secrets of nature and of the fine things which the best of humanity has achieved will not only give us pleasant things to think about while we work with our hands, but will fill our souls with higher ambitions and awaken the best that is in us.

We need to teach art in school, not because we expect to make artists of the children, but because in attempting to paint a flower or a sunset, the children come to appreciate their beauty and find joy in them.

We need to teach music, not to make musicians, but to express our deeper feelings. When the work of the day is over, a little music is both restful and uplifting. It adds the crowning touch to the family life, and helps make the home ties strong enough to hold the boys and girls.

Life on the farm, because it lies so close to nature, because it is in the midst of trees and birds and flowers, of herds and fields of grain, ought to be accompanied by the highest thinking and the greatest refinement. The quiet of the country life, away from the noise of the city, encourages thinking in minds that are stored with material for thoughts. Dreams, perhaps we call them; but the greatest success in life comes only to those who can think out plans, who can imagine something better than they have, and work to make their dreams come true.

**Making the most of oneself.** Getting the most out of life includes developing all one's talents to their highest capacity. Not every farmer's son has the qualities needed to make a successful farmer. Some cannot take the lead and manage alone, but will succeed better earning a salary under another person's direction. Some will have strong powers in other fields. We are proud to count the great statesmen and leaders in other fields who spent their childhood in the country.

The country school should offer at least the beginnings of a broad education through which every pupil may find himself and discover what he is best fitted for. "There ain't no great good to be reached by tiptoeing children up higher than ever their fathers was teached," said a backwoods school visitor; but the world is moving forward, and unless your boy and girl move with it, the world will leave them behind. They need opportunities which you did not need a generation ago.

Modern science has changed the world's ways of working and living. In every field, greater preparation is needed, if one is to succeed. The children must begin where the fathers are leaving off, and must "tiptoe" much higher or else fall behind. The country school must give country children a preparation as good as the best—nothing less is entirely worthy of them.

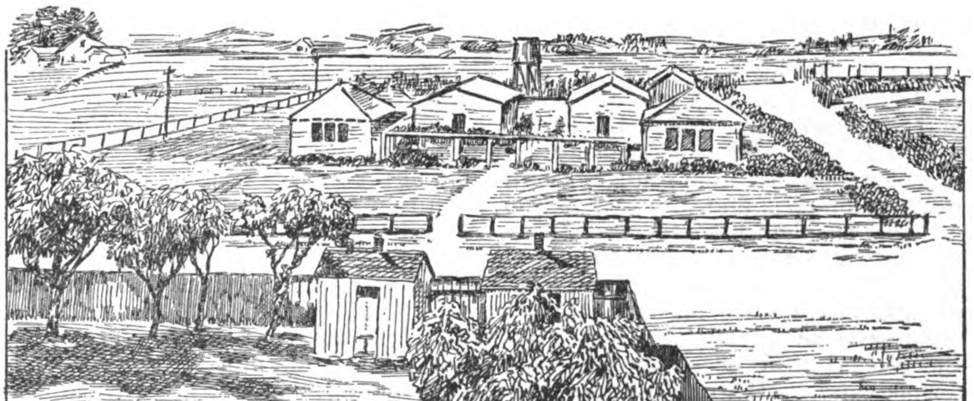
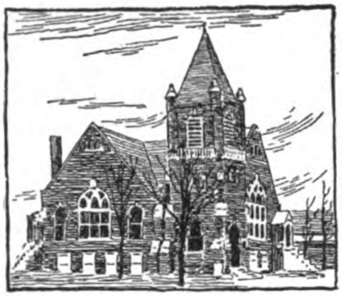
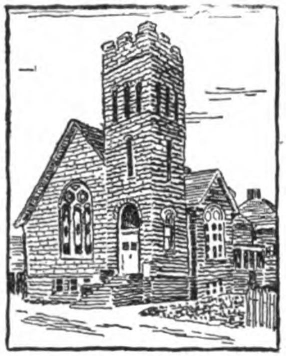


FIG. 255. A rural high school in California that accommodates 89 students. The building cost $5,500, the equipment cost $2,500, and the maintenance cost is $8,500 a year. It has nine acres of land on which the pupils have planted some twelve hundred fruit trees. ("Journal of Agriculture," University of California.)





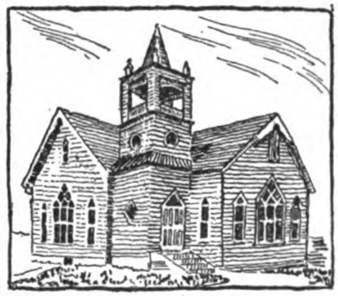


FIG. 256. These three churches are in a large, progressive Indiana village in which there is a consolidated school. Compare with those shown in Fig. 259

CHAPTER 15

# The Farm Community

AS FAMILY life is simply a larger expression of the life and activities of the individuals who compose it, so community life, in the main, represents the collective experiences and tendencies of its family units. This is especially true in rural districts where the families are fewer, more distinct, and yet more dependent one upon another, than in the cities. In every city there are thousands of families that do not know by name or sight one out of fifty of the families that live within a block of them; indeed, it is not unusual for the tenants of the same apartment house to remain unknown to one another for years.

Such isolation is practically impossible in a farm section. Each family is too obviously a sharer in the community activities, too big a factor for good or evil, too rich in its promise of neighborliness and coöperation, to remain unknown. Even though tastes may differ and social or political or religious affiliations fail to correspond, there is the common ground of community development upon which all can and must meet and join forces.

Under these circumstances, the full development of community life becomes not only easier but also more necessary. The farm community is not a center of interests as the city is. It is a producing rather than a consuming point; its products are, usually, not concentrated but shipped away in small consignments; it does not attract business nor the recreations and interests and multitudes that follow the lead of trade and commerce. On the contrary, it is self-supporting, self-amusing, self-instructing, self-developing. The problem of making its life useful, efficient, full and productive is, therefore, in some respects simpler, and in others harder, than that of any city.

This problem involves two stages. The first is the creation of community interests and activities—of a community spirit; the second is the maintenance of that spirit at the point of greatest vitality and benefit. Each of the phases of farm community life that are discussed in this chapter must therefore be considered as having two possibilities; the first that of community builder; the second that of community supporter. Thus an organization may be formed and, perhaps, unconsciously, create a new, unified, progressive sentiment in the village or township. But its work does not stop there; it must continue to interest its members, to hold them together and to keep them active in its behalf and in that of the community. So with the church or the school as a center, or the institute as an awakening point, or the historical

pageant as a creator of local pride; each must not be merely a flash in the pan, a valuable temporary experience; it must be perpetual and constantly growing in scope and improving in effectiveness. Let each individual take it upon himself or herself to be a little better citizen, a little kinder neighbor, a little heartier booster of the home town or county. Let every family express and strive to carry out the same endeavor. So will be born and flourish a community life that will serve and prosper, that will be a joy unto itself and a source of pride and strength and honor to the Nation.—EDITOR.

# THE CHURCH AND THE SCHOOL AS COMMUNITY BUILDERS

By MRS. HELEN JOHNSON KEYES (*see previous chapters*) *whose interests are, and long have been, with the people of the country. As already indicated* (*in Chapter 14*) *the educational systems in the country are undergoing great and admirable changes—changes that are making them more practical, more useful, and broader. As religion is an even more personal matter than education, the country church has been slower to feel the pull of modern tendencies. But a long step forward has been taken in more than one community, and the number of localities is constantly increasing wherein it has won a secure place as the center of community interest.*—EDITOR.

THE church and the school are among the greatest of community builders. As country people, we are coming more and more to appreciate just what the rural church and school mean to us. Each year we value them more highly and see in their work a real call to service.

**The pioneer's church.** Long ago, farming was a more lonely occupation than it is to-day. The pioneer farmed for his own family alone, and manufactured crudely for his own needs; consequently, he was brought very little into relationship with the world or even with other families. Because of the conditions under which he lived, his religion was largely personal. It was a message of salvation to his own soul, and came to him through conversion and faith, making no demands upon him for what we to-day call social service; for there was then no community to serve. The revival, held once or twice a year, and an occasional religious service on Sunday, were sufficient.

By and by the scattered, lonely cabins of the pioneers were replaced by groups of farmhouses. In this period, religion added to its message of personal salvation insistence on personal purity, temperance, and faithfulness to family obligations.

**The community church.** To-day, the farmer has been brought more fully into the commonwealth of the world. He is no longer isolated and independent, disputing his rights with wolves and savages; he is no longer confined to his own home, a rival of his neighbors, depending on their failure for his success. He is a member of a community and related to the whole world. Therefore, his religion, in addition to being a message of personal salvation, and besides insisting on family obligations, lays upon his church and upon him the duty of building up the neighborhood.

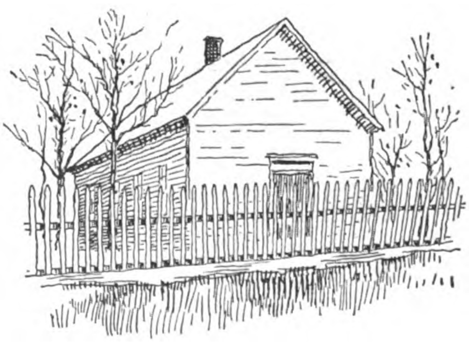


FIG. 257. A deserted church may mean that it has been discarded for something better, but usually it points to a lifeless, unprogressive community.

## The Church as a Community Builder

**What the church ought to mean to the community.** Much fault has been found with the old-fashioned parlor, which was opened only when the preach-

er came. May we not also justly criticise the church that is opened only when the preacher comes, and especially so when there is preaching but once a month? The church ought to, and must, if it is to fulfill its highest mission, mean more—to country boys and girls especially—than a gloomy, musty building back of which is the graveyard.

**The community house.** Where there is no community house, the church building or the schoolhouse should become the common meeting place for the people. It is fortunate if the church building has special rooms, such as are found in modern city houses of worship and in some country churches; but these are not necessary. The important thing is to use, for the greatest good of all the people, such room as there is. People who go to the church house for pleasure, for instruction in farm work, or for conferences, will go there to worship also.

**Play as well as prayer.** The churchyard should extend well back from the road, and should be large enough to afford, in addition to hitchyards for horses and parking grounds for automobiles, a playground for the young people—for all who are young in spirit, even though they may be old in years. Play is nature's safety valve; and it is a fine thing if this play can be under the direction of the pastor, or, at least, can be where the influences are good. It is a wise country pastor who understands the value of organized play, who sees in a baseball nine, a basketball team, a band, an orchestra, or a chorus real possibilities for developing team work and leadership. These qualities lead to community pride, contentment, and appreciation.

**The kind of preacher needed.** In rural churches, we must have pastors and priests who understand and who are in sympathy with farm life. There is a true story of a priest who came to a poverty-stricken parish in the open country. His people were too poor and too discouraged to support the church. Not all the most eloquent and inspired sermons in the world would have made it possible for them to contribute enough money or time to their church to make it strong. The priest saw this. He studied the soil and found that the people were poor because they were trying to raise crops to which it was not adapted. He became convinced that dairying was the proper industry for the region, so he learned a great deal about dairying, and at last built a cheese factory. In 10 years the parish had become so rich that it erected a beautiful stone church out on the country road. By creating a sound agricultural practice, this priest built up a community which, in its turn, supported a vigorous church.

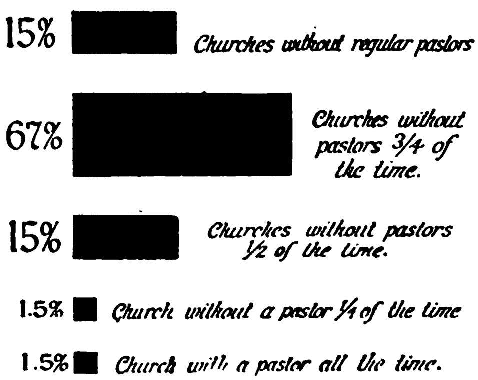



Fig. 258. Chart showing how the reduction in members of country congregations is influenced by the amount and kind of religious guidance provided.

We must have a resident minister. Only the minister who is right out in his field can get the best of team work from the men, women, and children of his congregation. He must know which boys have community pride and good business sense, so that they will, for instance, work hard to repair bad bits of road and thus reduce the cost of hauling. He must know his men, and direct the right ones along the paths of leadership in buying and selling and in the opening up of markets as well as along strictly religious lines. In so doing he will make possible stronger country churches, although these

churches will not always be like city churches. It is within the power of such a preacher to make those with whom he labors feel that honest agriculture is only just below the Ten Commandments in holiness, and to give them a vision. Without a vision the people perish. This is especially true of country people, who too long have suffered for lack of vision and want of leaders.

**What the church needs from the community.** Every church needs a united, devoted people. No minister can do his best work unless he has a congregation of considerable size, and one which is interested and able to support the church with labor and money.

## Kinds of Churches

Four types of churches minister to the farmer, but there are certain demands which each of them makes upon its community. We have (a) the church of the open country, (b) the church of the hamlet, (c) the church of the village, and (d) the church of the small city.

**The church of the open country.** The church of the open country, 95 per cent of whose congregation are usually farmers, and which is from 7 to 20 miles from a trading center, needs a group of permanent landowners, practising sound agriculture, supporting happy homes and practical schools, and living near enough to one another and to the church to permit attendance on Sundays as well as at the society meetings and socials. The church of the open country cannot thrive if the neighborhood which belongs to it geographically is divided up among too many denominations, each seeking to support its own congregation; for small groups of people are not able to feed enough strength into a church to make it a community power. The result is merely a number of poverty-stricken, weak worshiping places, often without resident ministers, and unable to meet the call of present needs. The church of the open country demands that rural people unite in making the church a constructive influence, under a pastor who is more than preacher and who is paid a fair salary. He should live in the country and close to the church. This means that there should be, near every live country church, a parsonage together with at least a few acres of land.

The preacher need not be the best farmer in the community; he need not attempt to become the community farm adviser or agricultural agent, but he should have a fair knowledge of farming. Without this, he will often feel at a loss in talking with the people of his congregation, and may actually lose in influence. Many a man can reach another through an understanding of his work, when he cannot do so in any other way. Nobody questions the value of agricultural knowledge on the part of the country banker or the country newspaper man. Surely it is just as important for the country preacher, who is brought into closer touch with the people than either of these.

Many successful pig clubs, calf clubs, colt shows, and community fairs have been built up around country churches. Through such movements are worth-while country things revealed and new possibilities pointed out. Thus are more people interested in the country and kept there, and the rural church strengthened.

**The church of the hamlet.** The church of the hamlet, about 75 per cent of whose parishioners are farmers, makes this same demand upon



FIG. 259. Three churches in an Indiana village of forty inhabitants. That at the left is dead; that at the right is dying; that in the center is furnishing the religious life for the whole community. The smaller the field, the more effective and economical is consolidation, whether in church or in school organization.

Fig. 260. People's hall in Honey Creek, Wisconsin, used, under the supervision of the church trustees, for farmers' institutes, lecture courses and community entertainments, as well as church functions.

us, and the demand for the same kind of pastor. It is more closely in touch with schools, with merchants, and with social agencies than is the church of the open country; and it asks of us constant coöperation with schools, business, and all the organized and unorganized resources for pleasure which help to make the hamlet a center. It demands our assistance in creating intelligent, honest, and wholesome influences which shall give stability to the hamlet itself and prosperity and permanence to outlying farm homes. It needs progressive teachers who will bring good schools and real homes close together; honest farmers and traders who will work, not against one another, but with one another. If we encourage these things, we shall form a neighborhood which, in its turn, will support a strong church.

**The village church.** The village can often support two or more churches, provided the surrounding countryside is not already supplied with an open-country or a hamlet church. As more miles of good road and of trolley lines are built, and as more farmers own automobiles, the village church is likely to grow in favor with the farmer. At present, he supplies about 50 per cent of its membership. The many occupations represented in it make it finely democratic. This church makes all the demands that the hamlet church makes and more. It cannot prosper unless the members of all the different callings which it represents are working together, both in their business relations, which are constant, and in their religious and social relations.

**The church of the small city.** The small city, with a population of from 2,000 to 5,000, may support several denominations; and in this way it offers a choice in the form of worship and in its missionary interests which is often welcome. Sometimes one of these churches broadens its field by doing work with an open-country, village, or hamlet church, and in this way becomes a community center for the outlying country. This arrangement requires a minister who is thoroughly rural in experience and sympathy. He should go among his open-country people, and should see that they are brought into touch with educational influences and amusements. It is equally important that the city, for its own sake, be brought into closer relationship with the country. The church of the small city requires democracy of all its people.

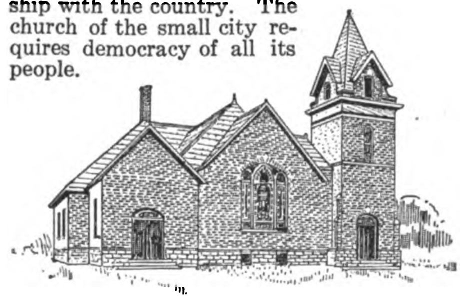


Fig. 261. The church in Honey Creek, the program of which is an important community movement. (This and Fig. 260 Wis. Bulletin 278.)

**National organizations must help.** It is a matter of vast importance to agriculture that the national organizations of the various denominations should grasp the rural-church problem. Fortunately, there has been a great awakening since the publication of a series of surveys of the country church in various parts of the country. From everywhere (except the southern states which generally suffer little from overchurching) come reports, in regard to Protestant country congregations to the effect that:

(1) There are on an average 80 weak country churches where there is only enough population to support 20 in strength and prosperity. (2) Within 20 years, church attendance has declined from 29 to 33 per cent, after taking into account the falling off of Protestant population in many sections of the country. (3) Country ministers, in proportion to the purchasing price of the dollar, are receiving salaries which are smaller than they were 20 years ago. (4) Of our open-country churches only about 6 per cent, and of the hamlet and village churches only about 25 per cent have resident pastors.

**Some remedies proposed.** To change the situation shown by the surveys, various remedies have been proposed. Some investigators, who have care-

fully studied the question, suggest fewer and stronger churches. Another plan, and one which might not prove so easy, is to get more workers into the church rather than to do away with all the weak organizations. Attendance figures prove that, in many communities, only a small percentage of the people go to church regularly. This being true, it is plain that not all weak congregations are the result of overchurching. In some states, committees of church leaders are developing programs through which they hope to make use of all the community-building strength of all the rural people. In other states, there have been organized interdenominational country commissions which are discouraging the organization of churches which are not needed.

To educate ministers for rural charges, the Department of Church and Country Life of the Presbyterian Board of Home Missions holds each summer graduate courses. It is urged that Bible colleges and other religious schools be established near the agricultural colleges, where farm life is felt and where it is seen as a reality. Many agricultural colleges are offering special courses for rural pastors, and district and state country-life conferences are common.

## The School as a Community Builder

**What it is and what it must do.** No longer do we feel that education consists alone in learning from books, that the term when we should study ends when youth ends. The old standards served in a way for olden times, when the farmer required little knowledge beyond the three R's and those farming and household practices which he learned in his daily duties. This was the period of self-centered homes. Then the early settler built little schoolhouses a few miles apart all through the countryside. Now, our life has become community life; and our schools, like our churches, must accept a new duty—that of becoming community builders, of making education include social relations, creating a neighborhood. To do this, the school must promote: (1) Homes in which are wise parents and home-makers and where, consequently, sound citizens may grow up; for neither the school without the home nor the home without the school can give children the new education. (2) Such a church as has been described. (3) Organizations which, by combining the various talents and experiences of the people in a neighborhood, may build up a prosperous community.

Schools cannot do this work unless their teachers are in sympathy with farm life and are the friends of every home; unless the schoolhouses are meeting places for the people of the nearby farms.

**What the teacher should be and believe in.** Mabel Carney, herself a country teacher and a trainer of country teachers, calls these brave men and women "links between the people and their opportunities." So the teacher should, first of all, be a man or woman of vision, and with sufficient training to make others catch the vision. This may mean higher qualifications, but to raise the standard is to take a most important step. The teacher of a country school should be more than an untrained boy or girl who is using the position as a stepping-stone to something else. A trained, educated, and capable teacher is just as necessary in the country as in the city.

First of all, the country teacher should believe in country boys and girls. This means, also, that the teacher should believe in the country as a place to live in, and see in it opportunities for the best talents; for only as we see can we teach others to see. Not to believe in the country is, unconsciously perhaps, to magnify the city while belittling the opportunities open to the country child.

**What should be taught.** The country school should educate for country life; but, in so doing, it should not neglect to lay a foundation broad enough to be of value alike in city and in country. Not all country-born boys and girls will spend their lives in the country. If we may judge by the past, a large percentage of them will go to the city. Those who would go must not be held back

FIG. 262. The choir marching into a federated Texas church in which community interest is well developed and maintained.

because of training that is too narrow, that is so practical from a farm viewpoint as to leave out much for which life has need. At this time, just when almost everybody is making a plea for rural training for country boys and girls, such a statement as this may sound strange. It is important, though, that it be kept in mind. Once in our schools there was but little practical training; now we must not swing too far in the opposite direction, and teach only of barrels and bushels and dollars and cents.

Still, in the country, the teaching should be in terms of country, life, and daily use should be made of that finest of all laboratories, the field. The "why" of agriculture should be stressed. For instance, the farm boy should be made to understand why it is best for him to stir the soil in the cornfield after each rain, even when there are no weeds. And there are thousands of other "whys" which, if answered, will cause the country child to see in his work, however hard, more than dirt and drudgery. The simple laws of animal and plant breeding are full of interest for almost every country child. In brief, the country school, in addition to laying a good general foundation, should stress the things which have to do with the farm.

**How to get a good teacher.** The wages paid to country teachers have been very much lower than those paid to teachers in the cities. School taxes, also, are lower in the country than in the city. Now, the only way to get good schools in the country is to pay for them, to pay just as the cities pay. Higher wages will make it possible to set higher standards, and to secure teachers measuring up to those standards. This support may seem slow in coming, but as the rural school serves better, it will be more liberally supported.

Politics should have no place in the selection of teachers, nor should family connections be considered. Qualifications alone should determine employment. Proper supervision and larger school units—perhaps the county unit system—with fewer officers will tend to raise the standard of teachers.

A home for the teacher has also proved a great help in the matter of getting and keeping experienced and well-qualified instructors. Farmers have found it worth while to build tenant houses for their farm hands. Why not, then, a home for the teacher?

**School buildings.** The average schoolhouse in the country is a one-room structure, but not always of the "box-car" type, so common in the past. The old house was an ugly, unpainted one with 2 or 3 windows on each side, a door in one end, rude wooden double seats for the pupils, and a big unjacketed stove in the middle of the room. In the new house, we note a proper arrangement of windows, so as to rest the eyes and save the sight of the pupils, comfortable single seats, some system of ventilation, and, perhaps, a furnace or, at least, a jacketed stove located with some thought as to the health and comfort of the children. Such a schoolhouse should provide not the common drinking cup, but a sanitary fountain, or, at all events, a drinking cup for each child. In many cases, such buildings are provided with good basements, affording furnace room and, on rainy days, a place for the children to play.

We have spoken of the one-room school. We also find in the country an ever-increasing number of school buildings of more than one room. In many of these are removable partitions, making it possible to throw together two or more rooms when a large space is needed to accommodate a crowd.

**Get the right kind of building.** It is not always possible to vote the money needed to pay for the right kind of a school building. Frequently, the proposition fails at first, only to succeed later, when it is better understood and when the need is more fully appreciated. In this connection, we would suggest that it is sometimes a mistake to be satisfied with a small bond issue or tax levy when more money is actually needed. The easy, sure way is not always the best. Schoolhouses, like other public buildings, must meet future needs as well as those of the present.

When it is not possible to vote a sum of money sufficient to build a new schoolhouse or to add to the old one, such amount as is available may be added to by contributions of cash or labor. Improving the schoolhouse in this way often develops team work and community co-operation of the best kind.

**What one community did.** A few years ago in a Missouri country district there was an old, weather-beaten, one-room schoolhouse. A new teacher was employed. She was a woman of fine training and of rare breadth of vision. She told the people of the district that they ought to be ashamed of their schoolhouse. They answered that it was impossible to vote funds to improve it or to build a new one. She came back with the very practical proposition that they raise what money they could and do the work themselves. The

proposition was agreed to. The schoolhouse was moved over, and the men came with scrapers and teams and picks and shovels. They dug a basement and in digging it, in working together in a common cause, they dug many little hatreds and jealousies out of their minds and hearts. In cementing that basement, friendships, too, were cemented, and the community life was strengthened. Once the work was started, it seemed that everybody could do something, and everybody did.

The opening of school that fall was a great event; for the building was, and to this day is, to the entire community, "our schoolhouse." Well may they be proud of it—one-room structure though it be. In the basement is a modern furnace, a sanitary drinking fountain, rooms for wraps, an oil stove, and a big removable table for use when the weather is too bad for the children to eat out of doors. The schoolroom, properly ventilated, screened, and lighted, is very different from what it was before the people of the district joined hands and went to work for the sake of the children. At the windows are adjustable shades, while paper that is restful to the eyes covers the walls, on which hang a few copies of paintings by great masters. Good slate blackboards have replaced the old wooden ones. Each pupil has a single desk of suitable size. Near the teacher's desk is a telephone, a part of the rural system and connecting with practically every home. Out in front of the schoolhouse, from a pole representing more team work, a flag floats. Wonderful has been the change, yet the actual expenditure of money was very little.

FIG. 263. A Minnesota country school building designed to shelter also social, religious and political activities of the community. It has five acres of grounds, and cost about $5,000. It is used as a school during the week, as a church on Sundays, and as a library and meeting place in the evenings.

**Linking up school and farm.** In using electricity, we cannot get results until proper connections are made. Just so with the school and the farm; until the proper connection is made between the two, we cannot develop and make use of the power. A close connection, however, makes the rural school a power house from which wires carrying community-building energy reach to every home in the district. Parents as well as pupils must be interested. Generally, though, the logical method is to reach the fathers and mothers through the children. For instance, a school-district survey made by the pupils will inform the parents of at least one thing that is being done "over there at the schoolhouse." Surveys lead to many questions as to crops, acreages, yields, and values, upon which help is sure to be asked at home. Discussions of farm practices follow. Why was the yield of a given crop better on one farm than on another? In some cases, the conclusion will be that it was due to the difference in soil. If corn be the crop under consideration, instruction on the selection of seed corn in the fall and on the testing of seed corn in the early spring, will be in order. A special "seed-corn day" for all the district, with school-trained pupils leading in selecting seed corn on the home farm, will naturally follow, just as will the school-district corn show later on. In the meantime, boys and girls will have brought seed ears from their homes and tested them in germinating boxes made

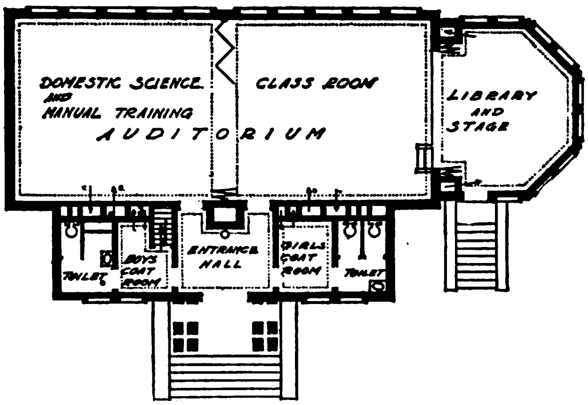



FIG. 264. Plan of the community school building shown in Fig. 263. Folding doors enable the two school rooms to be thrown into one large auditorium.

at school. Out of school corn shows have come many a district or community agricultural fair.

Teaching girls how to can fruits and vegetables may lead to the formation of a school canning club, which is sure to prove of interest to the mothers. Egg circles, through which eggs of guaranteed quality are collected and sold, to the advantage of the district, have been successfully conducted under school direction. Indeed, the formation of clubs of all kinds, especially pig, calf, and poultry clubs, should be promoted as actively as possible.

If only some of the work mentioned is carried out, the schoolhouse is almost sure to become a social center, where the people of the district may meet for pleasure, recreation, and instruction. There should be an active farm club, perhaps a series of farm lectures by representatives of the state college of agriculture or the United States Department of Agriculture, a week's short course in agriculture and domestic science, and, in some instances, an agricultural Chautauqua. In all these activities, as people come to know one another, they come to like one another. Developing team work for community building and betterment is then an easy matter.

"Boys and girls absorb environment," says Professor O. J. Kern, of the University of California, whose work as county superintendent resulted in the beautifying and betterment of the schools in an Illinois county. How important is it, then, especially where the schoolhouse serves as the meeting place for all the people of the district, that the environment—the house, inside and out, and the school grounds, too—should be right. Order, beauty, and cleanliness are considerations which greatly influence the life of the community.

## COMMUNITY ACTIVITIES FOR RECREATION AND BETTERMENT

*By* Mrs. Jessie Field Shambaugh, *who needs little introduction to country audiences, as the woman who, as a county school superintendent in Iowa, undertook and successfully accomplished the vitalizing of the rural schools, linking them up with farm life. Later she organized farm girl clubs throughout the country. Always she has made the greater welfare of the rural community her particular goal. In this article she has been asked to suggest, in terms of real farm needs and possibilities an answer to the question: What have we to take the place of the husking and spelling bees, the straw rides, the barn raisings and the other community frolics of earlier days?* —Editor.

GOOD times in the country. There is a wonderful chance for good times in the country. All around are the real things that alone can make true enjoyment—the beauty of sky and clouds and flowers and country roads; neighbors whom we know; the call to work which makes it fun to play when the work is done; and the simplicity and freedom of genuine friendliness.

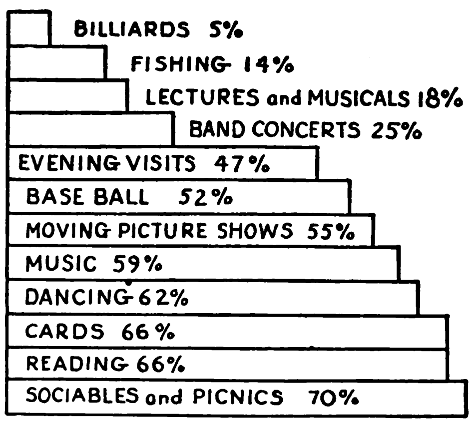



Fig. 265. Different forms of recreation and the percentages of the families in one rural township that partake of them. (University of Minnesota survey.)

**Each should contribute his share.** But we must all plan carefully and unselfishly, if we would make the most of this chance; for everyone—fathers and mothers, boys and girls, grandparents, and the hired help—has a

part in the right kind of good times in the country. Each can contribute his or her share to the merriment of the community. Not one will be forgotten by the wise leader. The chance for expression by all is the ideal.

FIG. 266. What is going to take the place of the husking bee in rural community life?

**A fine old legend.** Only on unselfish reciprocity, can the recreation of a community be firmly founded. Very much to the point here is the old, old legend of how the city of Jerusalem was founded. The legend runs that 2 brothers lived side by side. The elder brother had many acres and the younger brother but few. Harvest time came. The younger brother looked at his field and said: "I have an abundant harvest, but I have so few acres I could use it all myself. But there is my elder brother; though he has many acres, he has a large family and he might need more." So, when night came, the younger brother took sheaves of wheat in his arms and put them on the edge of his brother's field. Now the elder brother also looked at his field and said: "I have an abundant harvest and, to be sure, with my large family to care for, I could use it all myself; but there is my younger brother. I have always felt that I wanted to do things for him, and he might not have quite enough from his few acres for his needs." So, when night came, the elder brother took sheaves of wheat and put them on his younger brother's field. They did the same thing on the second night; and on the third night they met each other on the edge of the fields with sheaves of wheat in their arms. And it is said that this is where the city of Jerusalem was founded.

So, at the very basis of all planning for entertainments and recreation in a country community, is the remembrance that every one has something to bring. Every community has resources, in people and in material things, waiting to be used; it would help every community to take thought of what these may be.

**A community swimming hole.** A man was planning to make an irrigation reservoir for his orange ranch in southern California. His daughter, who had been away at school, said, "Father, would it be much trouble to make it shallower at one end and put some cement steps in there? And then it can be a swimming pool, too!" The father laughed. "Why, no, that's not much extra trouble or expense. I'll do it." And now, each summer, down the dusty roads for miles, on hot days, come boys and girls and grown-up folks for a swim.

**A pastor who loved boys.** In a country neighborhood in Ohio, there was no place for the boys to get together where they wouldn't need to be bothered with the fear of hurting the furniture or something else, until a live young pastor, who loved boys, discovered an unused loft in an old mill, which the owner gladly let the boys have and which, with the help of the minister, they fixed up just to suit boy taste.

**Sheltering groves and green pastures.** A farmer in Iowa planted a grove when he became a homesteader, for he thought how people love groves for picnics and good times in a prairie country. Always that grove was free for use for picnics and celebrations; and the beauty of the trees and the spirit of welcome and hospitality in the heart of the man who owned the grove combined to make all the good times there long to be remembered.

Pastures are fine places for a baseball diamond, and yards are large enough in the country for a volley ball and tennis court. Stretches of native timber, where wild flowers grow and birds come to nest, should be carefully preserved in every community for children and children's children to enjoy.

**Home, the greatest resource of all.** But the greatest resource of all, and the one most often neglected in our thoughts these days, is our home. A country home with doors that open wide, with music and gladness within, where young and old love to come and are always welcome, where there is never any "fuss" over company, but where everyone feels the warm glow of "being at home"—this is the greatest asset of the community, when we plan for the very happiest times.

**Learning to work together.** There are so many things right around us that we can use for good times in the country to-day, and, best of all, there is that neighborliness which makes it possible to develop the spirit of working together for the good of all which is the secret of all lasting joy. It's when neighbors come together to do something outside their own personal interests that there is real fun. The churchyard needs to be cleaned and flowers planted in it; a bad place in the road must be worked; or a neighbor is sick and his crops aren't yet in. Here is the opportunity to get together and do the work,

with a picnic dinner at noon, and a glow in hearts when it is done.

**A neighborhood porch.** In a South Carolina country-school district, the people decided they would like to have a big porch built on their schoolhouse, where they could have socials and lectures and from which they could watch the young people play basketball out on their court in the schoolyard. One mother, who saw far, thought that getting this porch built could be made into a good time. So every one helped. They even cut the trees for the great rough posts at the corners. It is a very nice porch. It belongs to every one, for every one helped some way in building it; and though they have had it 3 years now, and the floor begins to look worn from the many feet that have walked over it, they all still talk about the good time they had building it and what a jubilee there was when they dedicated it. Around two sides of this porch they are now planting a "celebrity garden," and they have written to some of the great men and women whom they specially admire, asking them what is their favorite flower and planting it. It is a unique garden, with everything in it, from sunflowers to Senator Tillman's roses, and is most interesting.

**Four acres for war orphans.** Another rural community set aside four acres near its consolidated school grounds to farm together, the proceeds to be used for helping French war orphans to have enough to eat. There are so many things to be done together in the world, and it is such a pleasure to do them. Perhaps this very spirit of true friendliness, of glad uniting in a common cause, is the greatest of all things that the people who live in country places have to bring to the world—a world which is seeking restlessly the way to human brotherhood.

**Activities of many kinds.** In planning socials, entertainments, and "get-together" times of all sorts, it is necessary to remember what it is that all people are wanting—friends, something to think about, something to laugh over, something to do, something to satisfy that longing for excitement, variety, companionship, and a knowledge of the beautiful which is in every heart.

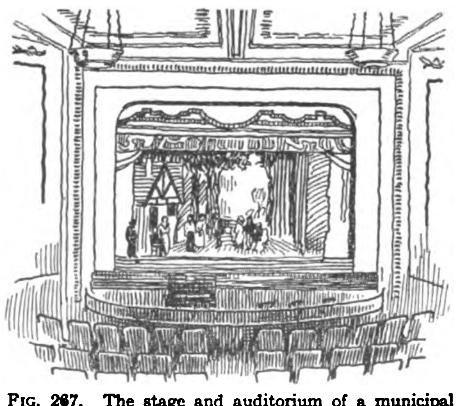


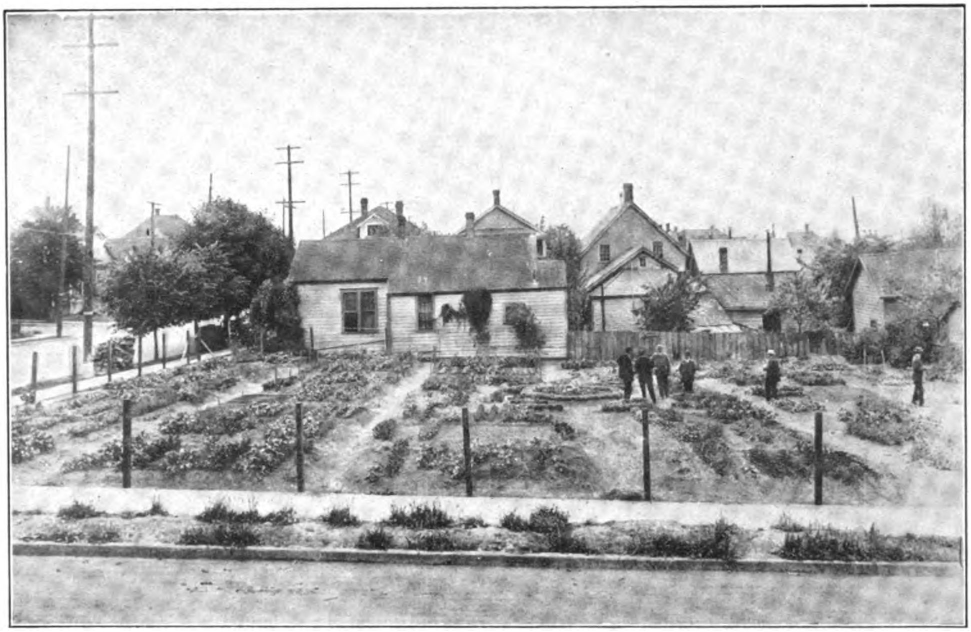
Fig. 267. The stage and auditorium of a municipal building in a Wisconsin rural county seat showing local artists preparing for a community play. (Wisconsin Bulletin 234.)

By entering thoroughly into our work in the country, and studying all that is back of what we do, a lot of pleasure can come to us in our everyday tasks. There is excitement in finding a good seed ear of corn and taking it to a corn show. A mother spoke truly when she said: "Since my boys have been studying about the best ways of farming, the rows are shorter for them, and I always hear them whistling as they come in from work." A girl will sing as she helps with the work of her home, if she enters into that work with her heart as well as with her hands; for it is the greatest joy to do things for the people we love.

So the country people of to-day have lots of good "get-together" times for this purpose of putting a lot of sunshine and interest and joy into everyday work, and every up-to-date farmer and his whole family have a part in them. The farmers' institute, or other meeting, brings its expert speakers, its chance for discussion, its exhibit, and its opportunities for the people to see one another and to sing together; and it's a big chance, too, to let the boys and girls have a part with reading, spelling, or ciphering contests, junior corn shows, bread baking, corn judging or stringing, and various other judging contests, colt shows, and the like. In many places, plowing contests have grown very popular in connection with these farmers' meetings.

Some communities are fortunate enough to have a short course in agriculture and home economics, lasting two weeks or more, with the best kind of teachers; and all states have a "Farmers' Week" during the winter at the state colleges of agriculture. There are counties which have camps for country boys and girls, under fine leadership, where the young people can study and have good times, and come home more proud than ever that they are from the country, because they know more of the opportunities there. Years ago, S. M. Jordan, of Missouri, saw the possibilities in a farm boys' encampment. Also, in many states there are state camps for boys and girls at the state fairs, where young people from all the counties in the state go. Then there's the county fair, which is not always all that it might be, but which country people themselves can make into a happy and helpful event with clean amusements and worth-while exhibits.

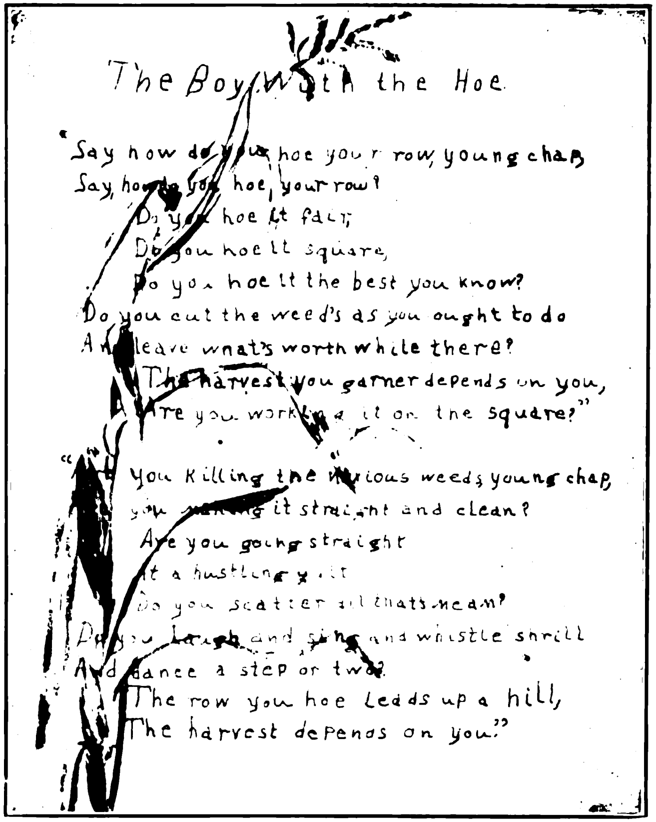
**Touring one's own county.** In a county in Pennsylvania, the Farm Improvement Bureau plans each year an automobile trip to visit all places and objects of interest to farm-



A boys' and girls' garden in Oregon showing what club work and enthusiasm did, in sixty days, to an ugly, useless backyard

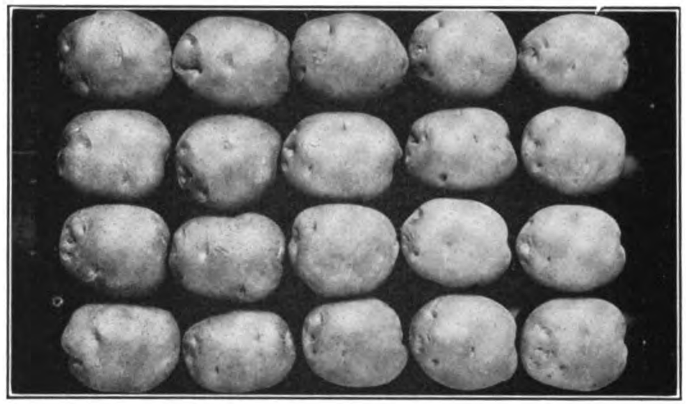

An exhibit in a farm boys' and girls' pageant and play festival

THE NEED OF THE CHILD ON THE FARM TO HAVE ITS ENERGIES GUIDED AND ENCOURAGED IS SPLENDIDLY MET BY CLUB-WORK. (Office of Extension Work, U. S. Dept. of Agriculture)




This poem was part of a booklet on "How I made my Crop," submitted by a prize winner in a Corn Club show

The boy who wrote the poem; and who, incidentally, made 150 bushels of corn on an acre



The exhibit made by the 1915 Minnesota Potato Club Champion

"THE CLUB BOY WITH THE HOE" IS THE GAINER NOT ONLY BY HIS CROP BUT ALSO BY A LONG STEP TOWARD A BROADER, DEEPER, MORE USEFUL MANHOOD. (Office of Extension Work, U. S. Dept. of Agr.)

ers—fine stock, new alfalfa fields, modern farm buildings, etc.,—near by; and hundreds of automobile loads go and enjoy seeing things together and they have a picnic dinner at noon. Entering into all these good times with enthusiasm brings not only pleasure at the time, but added pleasure in one's work afterwards.

**Chautauquas and motion pictures.** There is much of interest in the things that are connected with work on the farm; but now, more than ever before, country folks are called on to be world-wide in their interests. So there are Chautauquas, with their speakers on all subjects of current interest; and these and lecture courses, also, offer the opportunity to hear good music and see good pictures. Many of us are within reach of good moving pictures, and the best films offer much interest and diversion. Some country communities have put moving-picture machines in the auditoriums of their school buildings, and have a good film shown once a week or oftener. Films can be secured from the United States Department of Agriculture and, in many states, from the State Commission on Visual Education.

**Guideposts along the way.** Then there is all the world of friends and interest and romance to be found in books and magazines, which come right to our doors in these days. Reading circles, using some fine course, such as the Chautauqua system offers, or following the reading courses recommended by the United States Bureau of Education, for the completion of which certificates are offered, are worth while. The Young Women's Christian Association has a printed list of books and poems that country girls like, for which a beautiful bookmark is awarded as recognition when the books have been read and the poems memorized. County and state librarians are always glad to recommend reading for any club or group of country people. Free libraries, either traveling or local, are almost always available.

**Pay in play.** But it is not only things to think about, but things to do, things that work muscles as well as brains, that young people especially desire and need; and there is no surer way to help boys and girls to grow pure and good than to give them plenty of athletics and active exercise out of doors. The National Playground and Recreation Society of America, with headquarters in New York, furnishes some very helpful material along this line, including a "Standard Athletic Badge Test" for boys and for girls, for which they award a small bronze medal. The test requires very little apparatus, and can be easily undergone by the boys and girls in any country neighborhood.

Field meets for both boys and girls should be encouraged, locally and in townships and in the country. Team athletics, such as basketball, volley ball and baseball, are always

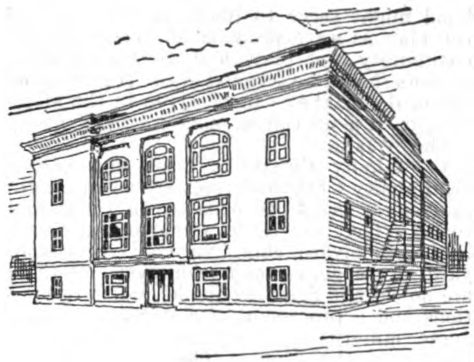


FIG. 268. The municipal building of which the theatre is shown in Fig. 267. It contains also offices for the city officials, a suite of assembly, dining, rest and other social rooms under the control of the local Woman's Federated Clubs, and the quarters of the Men's Commercial Club. It is a real community center. (Wis. Bulletin 234.)

good. Folk games out of doors with music, and all sorts of games, such as are described in Jessie Bancroft's book on "Plays and Games without Apparatus," are desirable. Hikes, swimming, riding, automobiling, fishing, hay rides, picnics, corn huskings, and all sorts of active good times together are right, and should be available for every one, but especially for the young people. Boys and girls should grow up used to having good times with one another in crowds under right leadership.

**Pageants and community plays.** Pageants are among the recent forms of community expression. These are a form of drama or play in which many people take part, and there is more in the music and the color and the action than there is in the words. Usually, pageants are given out of doors in some beautiful setting of trees and flowers. Many communities have written and given successfully local historical pageants, showing the development of the place from the earliest times, and closing with a tableau or prophecy as to its future. It is a chance to give credit to those who have helped in the hard pioneer times of the community and to bring to mind the traditions which are cherished. Inexpensive collections of pageants suitable for giving in country communities are available, but the best plan is to have the pageant written locally.

The National Anti-Tuberculosis Society has printed for free distribution a very interesting series of "Health Playlets," which may be effectively given by the children of a community. A student in a state college of agriculture has written a play entitled "Back to the Farm," which gives in a clever, entertaining way much of the philosophy of scientific farming.

A well-written dramatization of some book or poem by a person living in the neighbor-

hood might serve to illustrate the value of the play as an expression of the life of the community, but plays and dramas by great authors should be selected also. If performed out of doors, they can be given in the afternoon or, if plans can be made for the lighting, in the evening.

**Community Christmas trees and carols.** Community Christmas trees are as successful in country neighborhoods as in cities and towns. They can be set either out of doors, in the schoolyard, churchyard, or Grange-hall yard, or inside, as may seem best. If there are no electric lights available, pretty decorations and a procession of children with Japanese lanterns on long poles add to the beauty of the event. There need not be presents on the community Christmas tree; but the spirit of love and joy should be shown in abundance, and everyone should be remembered and given a chance to see the tree. Owners of automobiles should take the carol singers to sing to such old or sick people as could not come.

**"Get-together" dinners.** A community dinner once a year, preferably in the spring, in order to welcome the new tenants just after they have moved in, is the custom in some country neighborhoods. Events recognizing family relationships are pleasant, too. The girls in a country place in Kansas gave a party for their fathers. Mother-and-daughter banquets, father-and-son banquets, parties for grandmothers and for little brothers and sisters are popular in many country places.

**Good times and good friends.** It is very certain that whatever really good times people enjoy anywhere may be enjoyed at their best in the country; and no people deserve good times more or know how to enter into them better than country folk. And to-day, with better roads, swifter means of travel, more modern homes, with the masterpieces of music, art, and literature within our reach, with the most noted speakers coming near enough for us to hear them, and with the beauty of God's world all around us, everyone who lives in the country should have the opportunity of a real good time.

And with it all there must come that love for our neighbors which makes for eternal happiness. A farmer who had lived for many years in one community said near the end of his life: "I think I love everyone in the world—but, especially I love the people that live from Xenia to Cassar Creek." To love those who live around us as much as we love ourselves—this is the great secret of good times in the country.

# THE COMMUNITY LIBRARY

*By* EVELINE WARNER BRAINERD, *who was born on a Connecticut farm which she now owns and manages, and who is also a trained librarian. Volumes have been written about the ability of books to enrich human lives; but that they may do so they must be within reach. Many farm communities are fortunate enough to center around a village or be within reach of a town in which a library can be or already has been established. That it may make best use of such an opportunity, a community should know something of the workings and needs of a library, something of how to enlarge and improve it. These matters Miss Brainerd discusses out of her own experience as well as the accumulated knowledge of others.*—EDITOR.

UNLESS we include the various small collections of books found in rural schools, there are comparatively few libraries in the open country. We must, therefore, confine the present discussion to libraries in villages and small towns, excluding the deposit stations, or traveling libraries, operated by county libraries, which are treated in a separate article, below, on "Rural-Library Extension."

The best recipe for a village library, or indeed for any library, is that given by John Cotton Dana, head of a widely useful public library. He says: "Get a room, a flat-top desk, a plain bookcase, and a real librarian."

**The room or building.** Considering the room first—though, as a matter of fact, it is the least important, if most prominent, feature—how is the library to be started? The whole tendency to-day is toward the free library. This can be arranged by town action. The town votes a sum of money for the library and appoints a board. In most, if not all, states, the town-owned library has certain advantages. The state often grants it a sum each year for books, to be chosen from the excellent state lists. The disadvantage is that local politics may enter into the library management.

The Carnegie plan is to make a gift of the building, dependent, however, upon the raising by the community of an equal sum of money for the endowment. A building should never be accepted by a town or board of trustees without an assured endowment from some source; else, those responsible are likely to find themselves saddled with the upkeep of a costly building with no money for books or librarian.

If there be in the locality any historic or picturesque building, which refitted can serve conveniently as a library, all effort should be made to use it, even at the loss of a much more pretentious new structure. If, however, a new building is to be put up, make it fireproof, if possible; at least, make the stackroom fireproof.

**Arrangement and equipment.** The stacks, in any case, should be "skeleton," with cases of metal, not wood, as wooden ones hold dust and take up undue space and light. The woodwork of the building should be plain and easily cleaned; and careful attention should be given to heating, ventilation, and lighting.

There should be a children's reading room with high tables and chairs, as well as the low ones which are a matter of course. Quite often children grow beyond the size of small furniture before they are too mature for juvenile books. Where space is sufficient, other special reading rooms may be provided. All furniture should be plain, well-built, and comfortable. If the village already has a public hall that can be fitted with stage and footlights, it would be foolish to include one in the library building; but, in cases where there is no such opportunity for the young people to give plays and concerts, and for the delivery of lectures, a room with a stage or platform is a valuable addition to the library. However, the true value of a library should be in its books and in the suitable arrangements for getting at them and reading them.

**The librarian.** Certain traits of character and training are necessary to make a good librarian. For a small library, say, of less than 5000 books, a technically trained librarian is not necessary, although, other things being equal, one is always to be preferred. In any case, a trained cataloguer must be had to arrange the first books, start the catalogue, and plan the charging system. While the readers number under 100, the old-fashioned record book, supplemented by the librarian's memory, may be sufficient; but it is far better to begin with one of the card or slip systems. The Dewey system of classification is used throughout the country and is the best method thus far invented for keeping a growing collection classified, although the cataloguer should know how to simplify it for a small collection.

A librarian must, however, be more than a cataloguer. She should, to be sure, have a strong sense of order and system, and should write a clear hand, or, if not capable of this, should use the typewriter correctly. Besides possessing these accomplishments, she must enjoy helping people, and she must read books and love books, not alone her particular favorites, but all sorts of books; else, she will never know her library, and, if she does not know it, she can never direct readers.

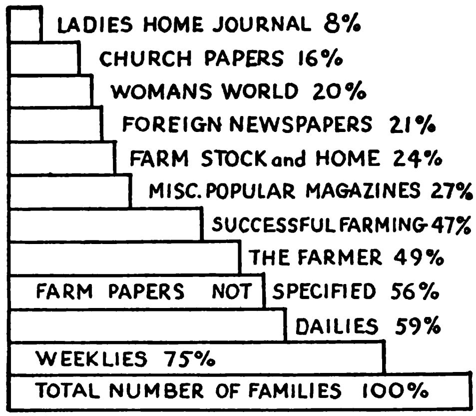



FIG. 269. What the families in one rural township read. From a survey made by the University of Minnesota

**Valuable old papers and books.** The librarian should be on the watch for the dismantling of old houses and see to it, if possible, that no attic collections of old papers and books are destroyed without being examined. In the most out-of-the-way corners may be found treasures which, if not valuable for her own library, may be given to the state or college collections, or sold to dealers for the benefit of the local book fund.

**Where to buy books.** In purchasing books, use, if possible, some local dealer, but if, because he is a small dealer, discount be small and delays long, search must be made among the larger book stores for better service. The library discount is now very small at best; and though, in some cases, better prices might be secured by ordering books from the publishers direct, the inconvenience of this and the extra cost in postage and express charges, makes the general book store the better market. If the store chosen takes magazine subscriptions, all those for library magazines can be renewed at one time, which will save much

FIG. 270. A central county public library in a thriving California farm community which typifies the wealth of the surrounding farms and the intelligence and progress of their owners.

delay. As to magazines, it is well to find out which of them are regularly subscribed for by the families which your library is to serve, and then to choose others.

**What the first selection of books should include.** The first selection of books requires much thought. It must be sufficiently attractive to win readers and supporters for the new enterprise; it must be a foundation on which to build further, and, because it is an experiment, it must have considerable variety, in order to serve as a test for future collections. It is well to decide on the number of books which shall be purchased as a starter, say 100, and to divide these up among the different fields—fiction, science, history, and biography.

**What reference books to buy.** Certain reference books are necessary. Make out a list of these; find out which are possessed by individuals in the community; and buy the others. In this way, you may, perhaps, postpone the purchase of a large dictionary and buy an agricultural or a general cyclopedia. Keep your original list of reference books needed, and to every purchase of general reading matter, try to add one reference work until you have a sufficient number of these for your community needs.

**Books must cover the field.** Do not overlook any interest or activity in your neighborhood. First of all in importance are sound books on agriculture, domestic science, and home hygiene. Then the Sunday-school teachers may stand in need of certain books; or the district-school collection may show many gaps which the teacher would like to have filled. According as the region is one where minerals, timber, oil, or special crops abound, choose your collections in a way to make local history and conditions more comprehensible and interesting. Remember the foreigners, too, who are present among you.

**Books on present-day problems.** In choosing histories, buy the shorter and more popular; and purchase, also, books which discuss authoritatively present-day problems, such as social welfare, labor questions, and foreign relations.

**Remember the children.** Make "juveniles" a large proportion of the first purchase. This is not often done in the opening of a small library; but, if the children of the community be attracted, the welfare of the library will be almost assured. Put money into well-illustrated books for children. Give the little folks fairy stories, legends, hero tales, simple biographies, adventurous history, natural history, mechanics, and elementary science—above all, the agriculture of their own farms. These must all be illustrated.

The publication of children's books has become a great commercial enterprise, and their wise purchase calls for careful discrimination. Never buy the new books for children till some responsible person has read them. Many good-looking books turned out each year, published, perhaps, by good firms and bearing on their covers the names of great organizations, are worthless trash, untrue to life, questionable in morals, and written in poor English. There are not many children's magazines, and most of these are expensive. However, there are a few of much merit and well worth what they cost.

**About binding.** Binding is expensive. Try several binders, and compare their work and prices, before sending out any great number of magazines or volumes. The remark may sound strange, but the magazines best worth binding are usually the children's, because children have the habit of reading and re-reading their favorite stories innumerable times, whereas grown-ups hasten on to new things.

**How to attract and interest readers.** With the library complete—rooms, librarian, books—how shall we attract the readers? This can be done only by advertising—not by large headlines in the newspapers, because different wares require different methods to introduce them, and the library is not a dry-goods store; but it is done by publicity, all the same. Reading notices in the papers about new books just in, or about books on certain topics of immediate interest, or appealing to certain classes in the community, are useful; one library had a most effective card for older boys and girls, explaining the use in one's career of such increased knowledge of one's work as books offer. Once a year there should be a public library meeting, at which the work of the library for the year is explained, its interesting features made much of, and its aims clearly shown. Here would be an opportunity for an address on some book topic by an outsider. But all such programs, if they are to be profitable, must be alive and connect up with the life of the community.

Within the library itself, much may be done to broaden its reach. First, the bulletin board must be kept varied and up to date. It must call attention to the new books as they come in. It must make mention of all gifts of books and their donors. It must

advertise books on current topics. Then all new books (save reference, fiction, and juveniles) and, of course, rare or costly volumes, should be placed for a time between book-holders on the tables in the reading room. In one small library, this experiment was tried, with the result that a dozen serious books on questions of the day were found at the end of a few months to be nearly as shabby from constant use as the most popular novel.

**Story hour and oral book review.** The story hour has long been a means of gathering children at the library and interesting them in worth-while literature. The same idea is behind the oral book review, in which the librarian, or some one else acquainted with the subject, gives an informal talk on the latest books purchased, on some special collection in the library, or on some special topic dealt with in a book. It takes much ability and effort to make known the practical value of books, or even to convince people of the pleasure there is in reading; but if the library does not succeed in some measure in thus impressing its community, it has failed in part of its task. This thought brings us back to Mr. Dana's recipe. Whatever your library goes without, don't let it lack a "real librarian."

# RURAL LIBRARY EXTENSION

By MARY EMOGENE HAZELTINE, *Preceptor of the Library School of the University of Wisconsin and supervisor of the public libraries of that state since 1906. She was born in western New York and has always kept in close touch with farm conditions. After graduating from Wellesley College in Massachusetts, she taught for two years in the Killingly township High School in Connecticut, gaining there a further knowledge of rural communities. From 1894 to 1906 she was librarian of the James Prendergast Free Library of Jamestown, N. Y., in which capacity she came in touch with the rural library situation in that state. With Wisconsin essentially an agricultural state, her present work has to do largely with library problems of the small towns and the open country, and requires a constant familiarity with rural library development throughout the country.* —EDITOR.

THE present-day hope, with its partial fulfillment, of a book from a free library for every rural dweller, marks a long stretch of time from the monastic libraries of the Middle Ages, where books were closely guarded for the use of priests and monks, and from the great university libraries of later centuries, where books were hoarded for scholars and the nobility, to the free lending libraries of American cities and towns, where books are provided for the free use of all residents.

**Origin of modern public-library movement.** The modern public-library movement began in our cities about 1876. To-day, almost every city and town throughout the country has its free library, well-organized and well-administered, where any of its citizens, of whatever age or estate, may borrow a book or a magazine for home reading, or may secure information on any desired subject from the books in the library through the aid of its trained workers. Almost immediately it was recognized that books did not belong exclusively to dwellers in cities and towns, but to the entire population, rural as well as urban. To aid in solving the problem of making free books available to all the people, state aid and supervision were naturally sought, following the method of the public schools, which have attained their wide and successful operation through state support.

Massachusetts was the first state to establish (in 1890) a library commission, which was "authorized to grant to any town, upon the establishment of a free public library, $100 in

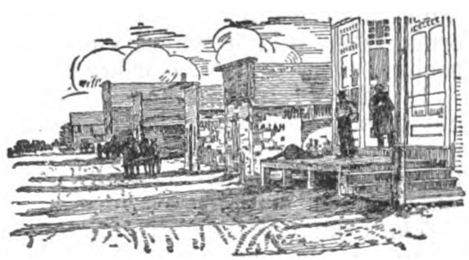


FIG. 271. This is the kind of community to which the traveling library carries comfort, encouragement and new ideas.

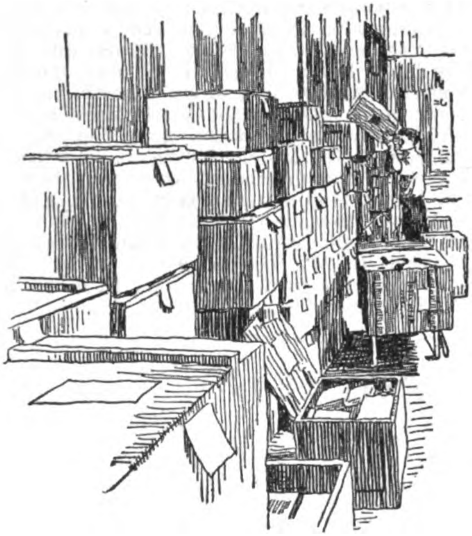


Fig. 272. Packing and shipping room of a state extension library

books." New Hampshire followed (in 1891) with a similar law. In 1892, New York developed a complete system of state supervision of libraries, and was the first state to establish traveling libraries, the distribution of these beginning in the following year.

This plan of supervision for better library development, for higher standards of service, and for library extension to the entire population, was followed by other states, until, in 1917, no fewer than 37 states were undertaking library extension work, either through a state library commission or through the state library itself.

Although the organization and methods of the several states differ materially, the common aim is to encourage the establishment of libraries in all communities able to support them, to promote the efficiency of libraries already established, and (in 30 states) to maintain a system of traveling libraries for the rural population. In spite of the fact that statistics show a great increase in the number of books in traveling libraries, a careful study of conditions in rural communities indicates that many millions of people either are not reached by these libraries or do not understand that they have these privileges.

**A book for everyone in the state.** It is a great problem for the state to reach out from its capital city with a book to every individual within its borders. While the state traveling library has done much in the years since 1892 to give everyone within the state boundaries the right book for his need or his pleasure, the very extent of the field has revealed its limitations. Consequently, a smaller unit, following the existing political organization, has been tried.

The first county libraries were established in Ohio in 1898, and the movement has spread from state to state, until to-day 15 states have passed laws authorizing county library work in one form or another. The county commissioners or other governing body may contract with an existing city library to extend its privileges to the whole county in return for a definite annual appropriation, or a new county library, supported by a tax levied on the whole county, may be created. The system has been very fully worked out in California, where a large majority of counties have well-developed county libraries reaching every part of their large districts.

In parts of Indiana and Iowa, the township has proved to be the better unit of organization, and occasionally several townships have united in supporting one library. In any case, the smaller field, whether township or county, makes possible a more personal contact between librarians and readers, and cuts down the shipping distance.

**The county library and its aim.** The fully organized county library aims to make books accessible to every reader or potential reader within its boundaries. Its distributing agencies are branch libraries with reading rooms in the larger towns and deposit stations or traveling libraries in the rural dis-

tricts, placed in the schools, in the village stores, and in the post offices. These small collections are made up to suit the type of community to which they are sent, are changed at frequent intervals, and are supplemented by a delivery service from the central library, which brings any particular book that may be desired. Isolated farmhouses may deal directly with the central library, receiving by parcel post a book ordered by post card or over the telephone. A collection of books from which to choose may actually be brought to the door by a book wagon, driven by one who cares both for books and for people, or, in up-to-date fashion, by a book auto. This latter makes trips on a regular schedule, interrupted only occasionally by impassable roads. Though this house-to-house delivery in rural districts is not yet common, it has passed the experimental stage, having been used in Washington County, Maryland, since 1901, and, more recently, in the Middle West, especially in Indiana. On a trip to the county seat, the library is one of the places to be visited, the farmer receiving the same service as the city resident, while the county teachers' association and other county organizations may meet in its auditorium.


FIG. 273. A traveling library in a country store. After a certain period these books are sent elsewhere and replaced by others.

The development of the idea of library extension, together with the working out of practical methods for carrying it into effect, has not been an isolated movement. Through the West, the women's clubs have been an active factor in supporting and even in initiating library service, several state federations having operated traveling library systems of their own before state library systems were established. The state and county fairs have given the opportunity for widespread publicity concerning the use of the books. The parcel-post system, good roads, and inexpensive automobiles have made the rural districts accessible. The centralized country school, with the many clubs growing up around it, is becoming a library center of distribution, not only for children, but for all classes and ages. So library extension will advance and perfect itself as rural communities develop.

**Farmers not alive to their privileges.** It would seem that a movement which has been developing since 1892, with the state to support it and librarians eager to push it, would have advanced more rapidly, especially in the

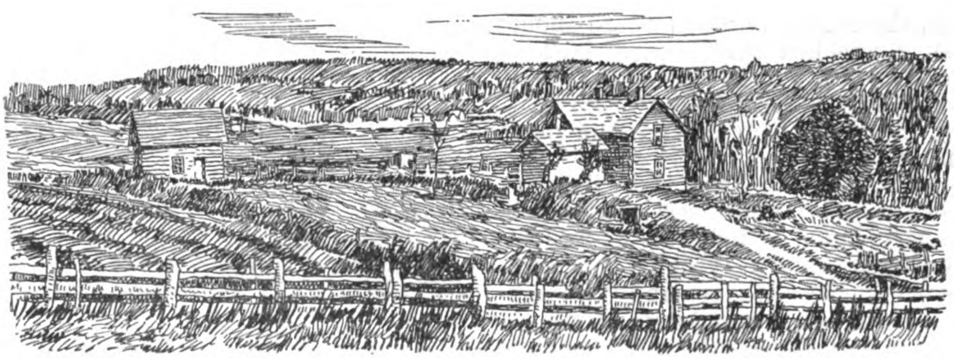


FIG. 274. Modern library extension work sends books by parcel post even to such isolated farm homes as this. Thus are farm folk held closer together and closer in touch with the advantages of more thickly settled communities

FIG. 275. The book wagon or traveling library is no longer an experiment in several states. It is simply an adaptation of extension methods to library aims.

last decade. It is safe to say that the trouble is largely with the farmer himself, who has not understood that he has these opportunities. Busy with practical affairs and the long day's work, he has not hitched his farm to a book, nor has his wife so hitched her home, while both have failed to appreciate the recreation that comes through reading. Besides, up-to-date books are among the potent means of helping to keep the boys and girls on the farm.

**How he can get and use library privileges.** With the experience that 25 years of rural-library extension affords, and the laws already on the statutes in many states, farm dwellers should be able to advance the cause to such a degree that the next decade shall show every country district as well supplied with free reading matter as the city precincts. This can be done if every farmer will study his state library law. County library privileges should also be investigated. When he has learnt what the law allows and what has actually been provided in his own state and county, let no farmer fail to utilize the service to the fullest extent. Books should be borrowed for all the family —"Mother Goose," to read to the baby; picture books for the youngest children and books to read to them; easy books and fairy tales for the children beginning to read for themselves; books of adventure and travel and good stories for the growing boy and girl; all kinds of books for the farmer and his wife, from tales of everyday affairs to accounts of the world beyond the sky line; and even a large-print edition of an old favorite for grandmother.

Having discovered and utilized these privileges, the news should be spread among the neighbors, at Grange meetings, in church, at fairs, in schools and neighborhood centers, wherever a word can be spoken. Personal recommendations and approval are the largest factors in modern publicity.

If, on searching for state and county laws, it is found either that they do not exist or are inadequate, the farmer should undertake, through the proper channels, to see that bills are drawn and legislation enacted that will bring library extension to his state. Or, if the laws are already made, but lack sufficient appropriation to render them effective, the necessary financial support should be authorized. If county or township service seems best for his locality, the county or town board should be approached with enough backing to prove the importance of the movement and a willingness to support it by the slight increase it would mean in taxation.

On the other hand, if he finds the laws ample, but the service poor, the matter should be followed up until improvement comes. It should be remembered that service is generally coördinated with local demand and patronage. The farmer should ask for the books he wants, and should expect good service,


FIG. 276. This library is part of the traveling equipment of a progressive county agent who knows what it means to an isolated farm family to be kept in touch with the interests of the world outside.

even delivery at his very door. He should know the authorities from whom to ask advice about books and reading, and for information and help on any subject. Further, he should demand that rural libraries, both as to books and the personal aid of the librarian, keep abreast in their development with libraries elsewhere. The farmer should be able to supply his book needs as easily as the town man who lives on the same street with the library. Let such library service be the slogan of all who live in the country.

## COMMUNITY MUSIC

*By* EVELINE WARNER BRAINERD, *who has taken an active part in all phases of community development. Love for music and the ability to create it, even among the peasant classes of a country, seem to be national characteristics of the Old World rather than of the New. For our part, the fact that we have no peasant class may account for this lack. Another may be the comparative youthfulness of our country, since folk music usually needs centuries in which to grow and ripen. Nevertheless, Americans do enjoy music, and given the necessary impetus and instruction, can make and fully enjoy it. Some of this stimulus is given by Miss Brainerd in the following discussion.*—EDITOR.

ONE of the great advantages of the country over the city is that all the interesting things are not done for one in the country; one has to take a part in the doing of them.

Community music should rank among the first of the many activities that grow up naturally in the country or in which it is comparatively easy to create interest. The real spirit of community music lies in the work of the people themselves, rather than in that of hired performers. The name may be new, but the idea is old.

**The old singing school.** Two generations ago a simple yet worth-while form of community music flourished in our country districts. This was the winter singing school. A teacher was hired, and paid a small fee representing contributions from each member; any one could join; and the whole village came and sang. This was before organs and pianos were common in the country, so the teacher carried his tuning fork from village to village.

**The village band.** Another form of community music is the village band. Although such bands, with their limited memberships, are a little more like clubs than some other community organizations, they are, nevertheless, fine examples of community spirit. They are organized primarily for serving at neighborhood functions, and usually for love of the work and because of pride in their village. The United States, though, is not a musical land. It ought to be. Music brings good cheer and a neighborly spirit. There is no more restful, more uplifting recreation. It is not, as we too often think, a luxury, but really a part of life, when we take the broadest view of what life should be and may become. To leave it out means not only that we miss a personal pleasure, but, also, that we have thrown away a great power for good, for social purification, and for happiness. There is probably nothing that serves so effectively to bind neighbors and groups and to give them a sense of good fellowship as music which they have made together. The church knows this and has always paid great attention to its singing.

**Soldiers should sing.** The army knows the value of music, and every training camp now has its instructor to teach and lead in singing. Formerly, before the World War brought new ideas and methods, thousands of men for the most part whistled as they marched, not because they did not like to sing, but because they knew no songs.

**Americans and music.** If America may not be classed as a musical country, yet many Americans love music. Each year vast sums are spent on the

operas and concerts in the large cities. Valuable as these are for the people who have the opportunity to enjoy them, they do not meet the great need of the country. Parents who make sacrifices to give their daughters music lessons, understand the desire and need we have for music in our homes. Often, however, these daughters are not able to learn to play enjoyably. Still the daughter who is not a pianist may, perhaps, become a good singer, and may heartily enjoy taking her part in a chorus. She may even take a new interest in piano playing, if "pieces" are no longer demanded from her, but merely accompaniments to the songs and hymns which the family and neighbors like to sing.

**What the singing of old German chorals did.** The chorus is the simplest and most important form which community music can take. Almost every one enjoys the realization that his voice is a part in that volume of sound which rises majestically from the mass of singers. The first large chorus in this country to attract popular notice was one in Bethlehem, Pennsylvania. There, even in the days of Benjamin Franklin, an ancient Moravian church was famous for its singing. Twenty years ago, or less, a new organist came to this church. For centuries, the Moravians had been singing the glorious old German chorals, and these alone. The young musician was struck with the beauty of the music and the earnestness of the singers. From his church choir, grew the Bach festivals which have made Bethlehem famous, and have caused it to become a gathering place for musicians and music lovers at Christmas and Easter. Yet, wonderful as is the singing, the singers are only the men and women of the neighborhood singing the music they love.

**Community singing in Connecticut.** Up in the hills of Litchfield, Connecticut, where winters are harsh, roads rough and steep, and houses scattered, there is a broader, and so a better, working out of the community-music idea. This movement, which grew from some free, open-air concerts on Norfolk Green, has been aided through the generous support of two local music lovers. The Litchfield Choral Union takes in 5 towns. A musical director gives a weekly lesson in each during 3 months of the year. Anyone who can sing is welcome. From these 5 groups is chosen the chorus for the annual festival. One year, 416 voices were selected out of a total of 700. From a population of 800 in one village, 110 are in the class. Such is the interest that some members, whose homes are outside of the villages, walk 3 or 4 miles or drive 10, week after week, winter after winter. Although the festival has grown to be a musical event of real importance outside of Litchfield County, the real value of the Choral Union is the happiness which it has given to the 5 villages. It has brought together all sorts and conditions of people. Catholic and Protestant, employer and employed, college man and laborer, landowner and renter, all have been bound together in a happy endeavor, a friendly enjoyment, a common neighborhood pride.

**Where the audience joined in.** In a country place of 6,000 people, a musician offered to train in singing as many people as would come. The closing concert was to be free, and the members of the class were to contribute 50 cents each to cover the incidental expenses. The people came and they sang. And not only that: they interested so much those who did not come that when, at the festival, the words of the Bach motet were distributed, in order that the audience might follow, the audience not only followed, but joined in also. Great was the surprise and delight of the leader, who, more than he knew, had awakened the love of music in a secluded community.

**Many states encourage the movement.** The Middle West has done more than any other part of the country in using the musical material at hand. State colleges, notably at the universities of Wisconsin, Kansas, and Michigan, have been leaders in spreading the knowledge that the making of music is within the power of almost all of us, if we only go at it in the right way. In Illinois, there are many bands and orchestras, and Indiana has her festival choruses. Richmond, Indiana, has a chorus of many grown folks besides the school choruses; and there they have wisely solved the problem of the full community orchestra by having the rarely used instruments owned by the community.

**Kansas a leader in community singing.** Thanks to the Dean of the School of Fine Arts of the University of Kansas, any one fortu-

FIG. 277. An outdoor song service. Music is nowhere more impressive than in the out-of-doors

nate enough to live in that state has only to write to Lawrence, if in want of advice as to programs, Victrola records for "appreciation concerts," or even of an organizer. And the people of Kansas do send to Lawrence, and the reports of the work of town orchestras and town choruses throughout the state show what comes of that. These towns are all beginning in a small way, like one, for instance, that gathered the people first for an informal "sing" in the lighted courthouse yard, and distributed the words of a few well-known songs, on leaflets given by the town printer. At the next "sing," in marched the town band, and that was the beginning of success. Winfield is a good example of the Kansas methods. Music there began very naturally with a high-school orchestra and a chorus, the two combining once a year for a concert. The one concert grew into a series of performances. Then the pupils who had left the high school and the people who had never been there, wanted to share in the good times of the chorus and orchestra. It was found, too, that professionals were glad to give their services for something that belonged to everyone. So out of the school music clubs came the community music; came special programs for children; came orchestra training as a part of the public-school curriculum; and came to Winfield itself the prize offered by the Child Welfare Department of the University of Kansas for the best town for children in the state.

**Two lads as leaders.** It was the singing of two lads coming home late in the evenings that turned attention to singing in another village. There had been musicians among its people in other days, but these were gone. They had left behind them, however, as memorials, a fine church organ and a beautiful piano, but nobody who could sing. At least, that was what everyone said till some one began to think about those boys singing along the road in the darkness. It was decided that the youths should have a singing teacher, and they brought into the class a few of their friends. The second year, the class became a large one, drawing in many of the people from the surrounding country. It was surprising what a difference there was in the village celebrations after this work had been going on awhile. The Sunday school opened with a song service which made even the least interested "sit up." The children had learned the delight of singing together, and the feeble little pipings from distant corners were things of the past.

There was a Christmas tree on the green that year. It was not a very big village, and a good many houses stood empty in December after the summer visitors had fled. But there were plenty of people, big and little, to see the tree lighted. The old Christmas carols rang out, and there were more Merry Christmases spoken than Santa Claus had heard before. Besides that, the few sick people and old people were made happier by the sound of carols under their windows, as different groups of their neighbors paused on their way home to surprise them with the season's greeting.

This village singing club has thus far contented itself with such celebrations, and with making ready for an Old Home Day on the Fourth of July by presenting a program, not only of our own patriotic songs, but of those of the nations from which the settlers came, and of those of the foreigners now settled in the town. They hope, another year, to combine with other nearby villages that are beginning to pay attention to the voices of the boys and girls, and thus to have a concert in which the whole county will be interested. This does not mean that they are going to use themselves up on the festival, so that they will not be ready for the everyday pleasure of singing at the usual town gatherings. The members are pledged to stand always for community music, never permitting quartet or solo work to displace the work of the largest possible number of people. They are going to make people think of the music, not of the musicians. The festival gathers together singers from many scattered communities; it gives them something definite to work for; and it necessitates the thorough study of some great musical composition. But, in addition to this festival work, a community chorus should study folk songs, patriotic airs, and all music that fits in with daily life.

**A hopeful field.** Each neighborhood, however, must adapt to its own needs and circumstances what is to be learned from those who have made a beginning in this hopeful field.

FIG. 278. A community band made up entirely of farm boys. Such an organization can add to their pleasure as well as that of all the neighborhood.

It does not, of course, follow that one community can do just what some other has done. The big truth to bear in mind is that, under the right plan, community music is everywhere possible.

# ORGANIZATIONS FOR RURAL COMMUNITY DEVELOPMENT

*By* MRS. HELEN JOHNSON KEYES, *who has personally taken part in or come in contact with most of the subjects she treats of. It is true that farmers have been slower to organize than most classes or groups of workers. But the peculiar and difficult conditions under which they work, make coöperation harder to bring about than in any other industry. Yet they have created and maintained some organizations that have attained considerable importance and extent. What these are, what they can do, and how their good effects can be increased by others are suggested here.*—EDITOR.

IN THE Colonial period, organization by farmers was occasional and temporary, chiefly for defense against Indians, or for the larger operations of agriculture, such as harvesting. Between 1869 and 1889, it existed mainly for the purpose of regulating, through politics, the business of other people, in order that monopolies and middlemen should not exploit the profits of the soil. Since 1889, it has assumed a somewhat new character, and, leaving politics to politicians, has bent its attention on its own business—not merely increased crop production, but buying, selling, storing, and transporting. Combined with these large economic programs, it has always had an educational and a social mission of great value, particularly in the small local units or clubs.

## Local Associations

It is, in fact, these local associations which are doing the most effective work in making the countryside sociable and attractive. It might be said that they have in charge the educational and social life of the American farm, although the widespreading network of local and Federal government agencies now operating in the country has drawn to itself many of the tasks which were once performed by voluntary associations; consequently, these latter have become coöperating forces instead of pioneer influences. Their strength, however, is increased by this fact. It matters little whether they are only local or are local units of state or national organizations; in every case they exist for the purpose of making life in the home more efficient with less labor, and life in the community more attractive.

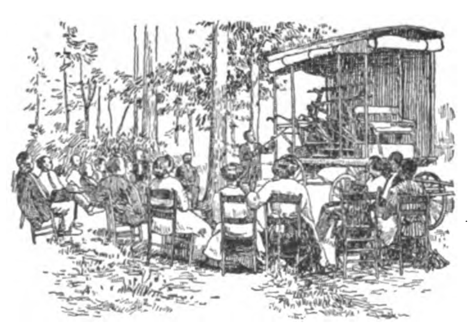


FIG. 279. A farmers' club demonstration meeting in the South. Social and educational activities are everywhere going hand in hand.

**Farmers' clubs.** So-called farmers' clubs include the entire family in their membership. They hold all-day sessions which are devoted to farming and farm-home problems, but are enlivened by music, recitations, debates, and dramatics by local or imported talent. The noon intermission is a great event, and includes a large dinner.

In most cases, each club is an entirely independent body; but in certain states, Michigan, for instance, the individual clubs are federated into the State Association of Farmers' Clubs. In 1908, no fewer than 120 clubs from 32 counties were included in this federation, with a membership of over 7,000. An annual state meeting of delegates is held.

**Farm women's clubs.** Farm women's clubs are strong influences in the new housekeeping and home-making. Many of them confine their programs almost entirely to housekeeping problems, the care of children, and the earning of pin money; others are more literary in their scope; and still others become travel clubs, assisted by the cheap prints of famous places, sold at a low price by publishing houses. Food is always an important part of the programs.

**Boys' clubs.** Boys' clubs are of value in turning to account the energies and talents of

youth, which are often wasted when not organized. Boys under 14 years of age need a young leader who inspires hero worship. A secret and a badge add greatly to the spirit of fellowship. The drafting of a constitution and the formal election of officers is a good lesson in government. The regular meetings should never be invaded by grown-ups; but the entertainments, debates, and athletics which are open to the public will welcome the coöperation of parents and friends, and may be mighty influences in promoting sympathy between 2 generations. So organized, the boys will enter heartily into community-improvement work.

**Girls' clubs.** Girls' clubs are of value in creating the good homemakers of the approaching generation. They put fun and pride into labor, and teach the joy and beauty of friendliness. Girls who have been members of these clubs will be better wives and mothers than they could have been without that training.

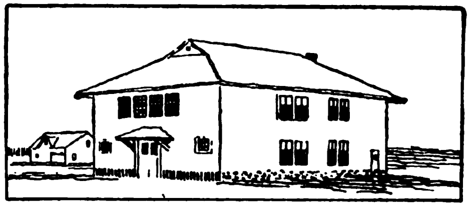
**Young people's clubs.** After boys and girls are 18 years of age, they can work together for all sorts of good things. Dramatics and pageants which illustrate local history can be staged by them, and exhibits of historic heirlooms have often promoted a local pride which has found expression in better home institutions and better citizenship.

**Parent-teacher associations.** Parent-teacher associations are doing a splendid work in bringing home and school into sympathy and coöperation. Every neighborhood ought to have one, and the mothers and fathers should meet with the teachers at least once a month during school term, and find out how they can help them. They should make the teachers welcome in their homes, and aid them in becoming familiar with the work and problems which the children encounter out of school. Neither home without school nor school without home can educate children. The two must join hands with the children in the center.

## National Organizations with Local Units

**The Grange, or the Patrons of Husbandry.** The Grange is a great national secret order. We know and love it best in its local groups, called "Subordinate Granges"; for these are community associations, made up of men, women, and young people over 14 years of age, who live in the same township or within a radius of 5 or 6 miles of one another. They are naturally bound together by a oneness of interest; for, to a great extent, they are all doing the same kind of farming, living in the same kind of home, and seeking the same kind of education and enjoyment. Beyond this, they are united by secret ritual, signs and passwords. The effect is to introduce a new tie between members of the same family (for membership frequently includes an entire household); to show neighbors how many things they can enjoy together; to speed up community efficiency; and to direct education and amusements toward real community needs.

The importance given by the Grange to woman's judgment and work has a very positive influence in extending her usefulness. It gives her an increased respect for her tasks at home and an active interest and influence in community betterment. Four offices in the Grange are necessarily filled by women, and others may be filled by them. That of lecturer in the Subordinate Granges is frequently held by a woman. Whether man or woman, the lecturer is charged as follows: "In selecting subjects, include the household and the home. A well-ordered household is essential to a happy home, and without a happy home, no farm is fully a success." With this idea in view, the National Grange has a home-economics committee; and the National Lecturer has prepared a handbook to aid the subordinate lecturers, in which is included home-economics work. Members of the Granges do well



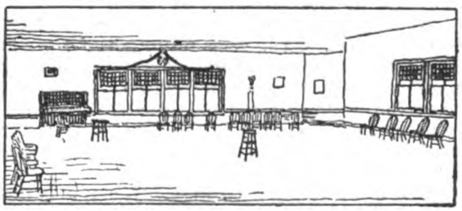


FIG. 280. Exterior (*above*); dining room (*center*); and assembly room (*below*) of a Grange hall in a small Wisconsin village. It contains also a kitchen, furnace room, men's smoking room, children's room and cloak room. It cost complete about $3,000 and is used for all sorts of social affairs as well as Grange meetings. (Wisconsin Bulletin 234.)

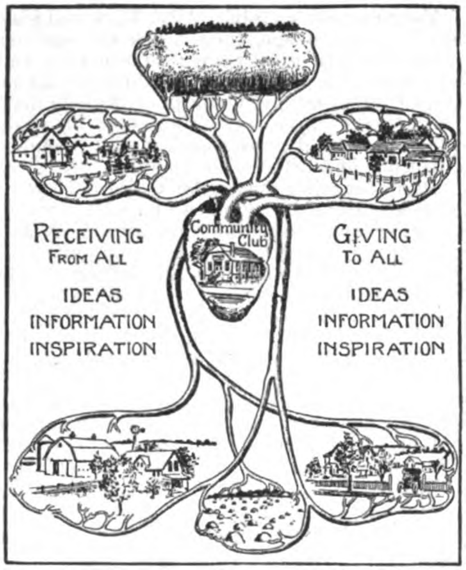



FIG. 281. The community club, rightly organized and conducted, can serve as the heart of the community through and by which a stream of inspiration and encouragement is sent to every member.

to qualify themselves for lecturing along household lines; they may also ask state colleges and other institutions to coöperate with them by supplying speakers. In line with this work, Subordinate Granges have greatly enhanced women's exhibits at state and county fairs by practical and helpful demonstrations of the home arts.

At each meeting of the Subordinate Granges, after the ritual is completed and the business transacted, there follows a program, which has been arranged by the lecturer. This may include music, recitations, readings, debates, and serious discussions of local conditions and needs. It may be followed by a "feast" or, as is frequently done, the session may be divided into two parts, the feast forming an excellent intermission, during which everyone is refreshed and stimulated by good food and by the exchange of ideas.

Meetings are often held in schoolhouses; and, when this is the case, an impetus is given to the valuable movement of making schools community-center meeting places. However, when Subordinate Granges are strong enough to erect their own halls, it is even better, for these are specially adapted to the social and educational life of the Grange.

**How to establish a Grange.** When it is desired to establish a Grange, the best plan to adopt is to write for a copy of the "National Grange Monthly," Westfield, Massachusetts, which will contain the name and address of the National Grand Master, who may be asked to send a copy of the last annual proceedings of the National Grange. This will give a list of the names and addresses of all the state masters. The master of the State Grange to which your Subordinate Grange will belong, will gladly coöperate with your neighborhood in every way, and will even send out organizers to start your work.

**Pomona and State Granges.** All the Subordinate Granges in one county often organize into a larger unit, called a "Pomona Grange." Pomona Granges have great monthly rallies, which comprise, as far as possible, the entire membership of the included Granges.

The State Granges are made up of delegates from the Subordinate Granges. They, as well as the National Grange, hold annual meetings only. Both of them are legislative and executive bodies and, considered by themselves, exert little social influence over the countryside. They are, however, the fountainheads of business, and clearing houses for subordinate activities.

**Organization and history of the order.** The Grange includes 7 degrees, the first 4 of which are conferred in the Subordinate Grange. The fifth degree is given in the Pomona Grange, the sixth in the State Grange, and the seventh in the National Grange.

The history of the Grange follows closely the development of farming as a science and a business since the Civil War. It has been the friend of almost every reform that has benefitted the farmer and his family since 1868. The study of its struggles and achievements might become with profit a part of the educational programs of Subordinate Granges.

**The Farmers' Educational and Coöperative Union of America** exists principally to regulate the business interests of farming. It is a secret order, exerting tremendous local influence, and possessing vast interests in fertilizer plants and in machinery and guano factories. By means of these Union-owned industries, localities are able to establish agencies for buying and selling in bulk, thereby driving to the wall small merchants as well as the retail agents of large interests. The Unions have sometimes been accused of impoverishing extended districts in this manner; but, in defense, they point to the increased efficiency on the farms, and to the larger incomes of farmers which have resulted. They maintain, moreover, that they have not used this boycott except when forced to it by unfair treatment. They are arrayed against the mortgage and credit system, and against graft, and they own a system of cotton warehouses in every cotton-growing state.

The order was organized in Texas in 1902, to exist for 50 years. It speedily absorbed a number of those organizations which had sprung up in rivalry of the Grange. By 1906, it had Unions in every southern state and in some northern ones. The total number in the United States was 6,870, and new charters were being issued at the rate of 25 a day. In

a few years, the membership reached 3,000,000; and it is still increasing, making steady headway in the North. Its membership includes both sexes, and receives Indians. Separate Unions have been established by negroes. Bankers, merchants, lawyers, and members of trusts and combines which might prove injurious to farming, are rigidly excluded from membership.

The order coöperates with organized labor, and pledges itself to give preference to the products of labor which is organized, and that its leaders shall coöperate with those of labor in efforts for legislative and political justice.

**The American Society of Equity of North America.** The local units of this National organization have great independence of action. Members are expected to extend fraternal care to one another in illness and misfortune. Harmony and brotherly debate are urged for the settlement of quarrels and disagreements. Meetings are held in the open country, in towns, and in hamlets. Its influence is mainly in the grain-growing belt. It was incorporated under the laws of Indiana in 1902, and is not a secret order. It exerts a strong influence in determining the prices of farmers' commodities.

## National and State Organizations Without Local Units

**The Dry-farming Congress.** The Dry-farming Congress is an efficient association, holding yearly meetings with a large body of delegates. Its purpose is not only to make the "desert blossom as the rose," but to encourage everywhere an agricultural practice which shall conserve moisture to the utmost.

**American International Congress of Farm Women.** The American International Congress of Farm Women, organized at Colorado Springs in 1911 as an adjunct or fellow body to the Dry-farming Congress, held a number of interesting annual sessions, one of them in Belgium, and several in connection with the Dry-farming Congress in our arid states. In 1914, it separated from the Dry-farming Congress, in order to make clear its nation-wide scope, and met independently in 1915, but has been little heard of since that time. Its weakness lay in its lack of basic organization.

**The Hartford Movement.** The Hartford movement in Vermont owes its beginning to 100 influential men in Hartford township, who organized in 7 groups, to promote better farming, better schools, and wiser and more abundant recreation. Out of the movement, grew the Greater Vermont Association and the Bennington County Improvement Association, which receives help from the United States and from the Grain Growers' Association. Other Vermont counties have organized in a similar way. The movement has consolidated churches, and improved religious and social conditions in small towns. It carries on summer conferences in the open country, and, with the churches as centers, it encourages extension teaching and correspondence courses in modern agriculture and housekeeping.

**The Amherst Movement.** This movement for the enriching of social life in a farming country, was started by President Kenyon A. Butterfield, of the Massachusetts State Agricultural College, situated at Amherst. Its special contribution is a 5-week summer school, which closes each year with a conference of agricultural educators and rural social workers. Although it gives attention to technical agriculture, its emphasis is laid on the problems of church and school and such subjects as organization, reading, and amusements.

## County Fair Associations

These associations provide in each county local agencies which operate through the different districts, encouraging organization among farmers and farm women in behalf of better production and better homes. They coöperate with the colleges in extension teaching; and the colleges, in turn, furnish the associations with exhibits, judges, and demonstrators for their shows. The results of their work are seen in the county fairs; but it is in the effort which local groups put forth in producing and preparing their exhibits that the real educational value of the movement lies. The people of the different neighborhoods may or may not hold regular meetings; but they are sure to visit together, in order to compare the results of their work, be it farming or household arts. Under community-spirited teachers, too, school-children are organized, in order to prepare their exhibits of sewing, cooking, and carpentry.

The feeling has become almost universal that these associations ought to become permanent, like the farmers' institutes, and not confine their activities to the short seasons when fairs are held. There is a tendency to employ as

fair-association secretary a man who is not a mere clerk, but an able agriculturist with the spirit of leadership, who will encourage an all-the-year-'round association, with every locality constantly alert in the study and practice of better farming and farm homes, and with neighbors brought together in frequent meetings for the exchange of ideas and the benefits of team work. Local fairs held in the schoolhouses or community halls are an excellent side activity of the associations.

## AGRICULTURAL FAIRS

*By* WM. L. NELSON *(see Chapter 9), who, as organizer, legislator, state official, representative of the press, practical farmer and student of men and things in the country, has had ample opportunity to arrive at definite and convincing conclusions about fairs. There has been a very noticeable change in these affairs, even within the present decade; for the most part, this change has been in the direction of improvement and greater usefulness. Mr. Nelson suggests how this change can be made still greater, and what is better, permanent.*—EDITOR.

THE agricultural fair, as we know it to-day, had its origin in the Old World fairs and market days. Bartering and buying led to comparison. As time went on, breeders met, compared, argued, and judged, as cattle were brought out for review. Gradually the sale features, while important, became secondary to the show. Competition created wider interest, and more people came to see and to learn. In the course of time, the idea spread to America. Here one of the first agricultural fairs was held in the District of Columbia, in 1804. In 1809, the Columbian Agricultural Society, whose membership included prominent residents of Maryland, Virginia, and the District of Columbia, held its first annual exhibition at Georgetown. One of the first country fairs in America was that of the Berkshire Agricultural Society, held at Pittsfield, Massachusetts, in 1810. A little more than a century later, the number of fairs—community, county, district, and state—in the United States was approximately 3,000, with a total attendance of several millions and with far-reaching influences.

**Fairs as community builders.** A fair has been defined as "a classified exposition of the products of the farm." As such, it is a great power for agricultural upbuilding and betterment. Fairs exert a wider influence, also. In fact, no organization working no greater number of days can do more for local social progress than can the fair that is clean, properly directed, and in full sympathy with its patrons. Such a fair more than mirrors the community; it educates and creates a desire for better things. Naturally, while building sentiment of the right kind, the fair is also serving as a business builder. Good livestock and choice field products, when exhibited at the fair, cause other farmers than the exhibitors to wish to breed better animals and to grow better crops. However, we are now thinking of fairs more especially as community builders.

**Good and bad fairs.** Fairs are variously classified; but, after all, they are either good or they are bad. The good fair is clean. It points the way to better living as well as to better livestock, and places morals and manhood above money. On the other hand, no matter how large the attendance or how complete the exhibits, the fair that openly encourages gambling, and licenses questionable and vulgar sideshows, is a failure. Boys and girls make up the best crop of the community. To make them secondary to any other, is a serious mistake. A clean fair represents more than good morals; it is good business. In every community there are more good people than bad, so that, in catering to the former, the fair management is working along lines that finally should prove profitable.

**Making the good fair better.** There are many things that can be done to make the good fair better. First of all, it should always be borne in mind that the fair is held for the people, and that, first of all, attention should be given to their health, comfort, and

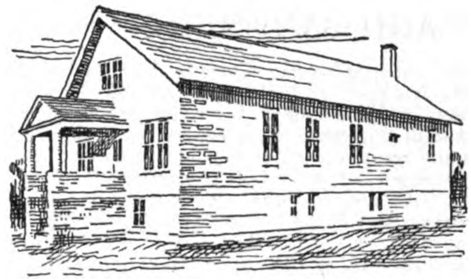


FIG. 282. A Wisconsin township hall built by a township tax for about $4,000, as the result of a movement started by the local Farmers' Club.

convenience. Accessible grounds, ample seating room, and decent toilet facilities must be provided. The picnic and social features are each year becoming more important. The automobile makes travel easy, and causes people to want to go somewhere. They will go to the fair, if proper inducements are held out. There must be ample parking places for cars; and it will be fortunate for the fair association if, in connection with the grounds, there is a well-shaded park. Pure drinking water, too, is necessary, if the crowds are to continue to come. With these things provided, visitors, meeting in a social way, can make a fair start toward entertaining themselves.

But there must be something to see. An up-to-date premium list, featuring the new things, holding fast to the old, and giving prominence to the activities and enterprises in which the lives of the people find fullest expression, will encourage large exhibits. Complete and proper classifications will also help. In livestock, these classifications are doubly important. Properly made, they encourage breeders to fit their best for the showring, and also make the exhibit of greater educational value to the onlookers. A competent judge, one in whose honesty and ability every exhibitor has confidence, should be engaged to pass upon the entries. Agricultural colleges supply such men, or some leading breeder may be selected.

Then, when the awards in any class have been made, the judge should be able to explain wherein one animal ranks above another. As the single-judge system comes more and more to replace the old-time committee of three, this feature grows in importance. Proper premiums attract entries, just as does a well-printed and carefully arranged premium list. Premiums should never be offered for freak exhibits, such as the largest egg or the tallest stalk of corn. It is better to feature the highest-scoring dozen of eggs or the best 10 ears of corn, quality and uniformity considered. The success of the community is not founded on freaks. These are not the things that pay for better schools, roads, and churches, that build comfortable homes, and make possible community entertainments. Special premiums for the best individual farm exhibit, the best school-district agricultural exhibit, the best township exhibit, or (in the case of a state fair) the best county exhibit, will help to fill the agricultural hall. One of the big problems of every fair association—and it is as yet unsolved—is how to make the money invested in fair grounds and equipment give direct returns to the community, county, or state, not only during fair week, but throughout the entire year. Larger uses to which fair grounds may be put are eagerly being sought.

**Indirect influences of fairs.** Fairs, whether good or bad, exert very strong indirect influences. The right kind of fair is both a character builder and a community builder. The week before such a fair is held, the community engages in a general clean-up. Company is coming, and the house—town or community—must be in order. Miles out in the country farmers join in the spirit. Fences are painted or whitewashed. and weeds along the roadsides are cut. More attention is given to the highways, which must be in good shape for the added travel that fair week brings. All these things have a good influence upon the people. One of the greatest of the many benefits that come from fairs is that of getting more people to take part in some community movement, to realize that they themselves are parts of a great coöperative concern. Every man who puts something into a fair, however little that something may be, gets something out of it. Interest in one community movement creates interest in others.

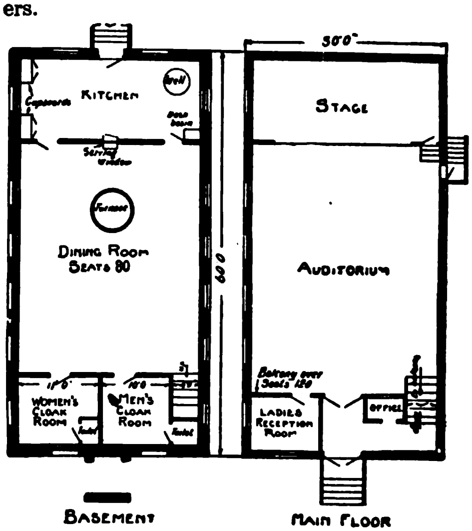



FIG. 283. Floor plans of the township hall shown in Fig. 281, which serves as a general gathering place for the whole community. (This and Fig. 281, Wis. Bulletin 271.)

# COMMUNITY HEALTH AND SANITATION

*By* MRS. DONALD BUDD ARMSTRONG, *who was born in a country village in New York State, now lives on a Massachusetts farm, and is especially interested in the study of community health problems and how to solve them. Since rural community health and its betterment is a comparatively recent field, she, like most workers in it, has had to gain much of her experience in centers of denser population. But the principles of sanitation are everywhere alike; and the health of a family is of the same importance whether it lives in city or country. At present she is applying the knowledge gained elsewhere in coöperating with her husband who is directing the Community Health and Tuberculosis Demonstration at Framingham, Massachusetts. It is often said that the strength of a nation lies in its country folk; this is but one of many vital reasons why they should, first, be taught how to keep themselves, and their neighbors, and their surroundings healthy, and, second, assisted in doing so.*—EDITOR.

PEOPLE always think that the country is more healthful than the city. It ought to be, but it is not. More babies die in every thousand born in the country districts than in the crowded sections of New York City. Tuberculosis, too, is almost as prevalent in rural communities as in cities.

The country is not to blame for this, but country people are. They have not used the natural advantages of the country, while city people, of recent years, have been fighting against the disadvantages to health of city life, and so have outdone the country folk, who pay little attention to healthful living.

## How to have Community Health

If each member of a family is healthy, then so is the family. The same is true of the community; for it is made up of families, just as a family is made up of individuals. Community health, then, is simply a larger family health.

In the city, each family has to depend on the city government to provide it with things which make health possible, such as pure air, pure food, pure water. The farm family is better off. No factories fill the air with smoke; no near-by houses shut off sunlight; each farm can control its own milk and water and much of its food supply. So there is no excuse for unwholesome living in rural communities. If each family keeps itself healthy, the whole community will be so.

What is necessary for health? We would say that, first, a person must *desire* health; second, he must *know how to get* health; and, third, he must *do and keep on doing* the things which will make him healthy and *avoid doing those things which will make him sick.* Family well-being depends on these same three things. All the members must work together to keep the house, the farm, and themselves in a sanitary and healthy condition; and so, too, must all the families work together to make the community well and strong.

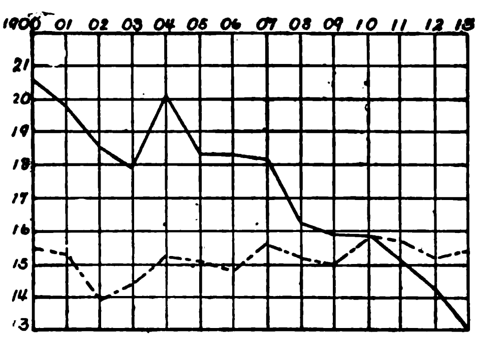



FIG. 284. City and country healthfulness compared. The solid line shows the death rate per 1,000 of population in New York City; the dotted line that in rural New York. Modern knowledge and scientific methods have steadily reduced the former. Conservatism and ignorance have left the country a more unhealthy place to live in than it has any reason or right to be. (N. Y. Dept. of Agriculture, Bulletin 62.)

To create health and prevent illness, four things are specially necessary. These are: (1) pure air; (2) pure, abundant, and wholesome food; (3) pure and abundant water; and (4) the observance of certain common-sense laws in respect to daily life.

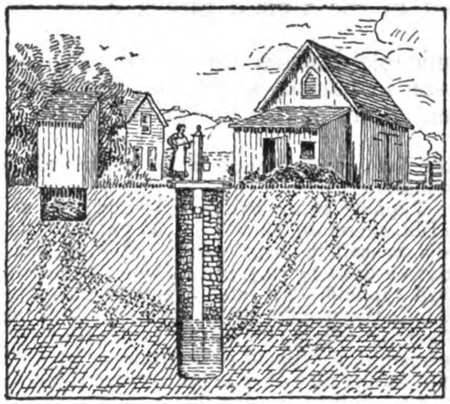


FIG. 285. Too many farm water supplies are polluted as shown here. This is one cause of the high rate of sickness and death in the country.

**Pure air.** Fresh air, winter and summer, night and day, for babies and everyone else, is needed to make good blood and sound lungs. It is necessary, too, because it is the best preventive of tuberculosis and consumption. Tuberculosis is not inherited; but a child whose relatives have it is more apt to get it, for 2 reasons: (1) he is built so that he is more susceptible to the germs; and (2) he is more exposed to the germs through living with someone who has it or in a house where someone has had it recently and which has not been properly cleaned and disinfected.

Every house should be cleaned and aired daily, in winter as well as in summer, even at the cost of extra fuel. Sunlight kills disease germs. Everyone, whatever his age, should always sleep with windows wide open. In case of sickness, especially colds, pneumonia, or tuberculosis, the sick person should have not less, but more, fresh air. Up-to-date doctors say that a serious case of pneumonia has a better chance of recovery out in a snowstorm than in a room with the windows closed. Delicate children should not be allowed to attend a school where windows are kept closed. Only old-fashioned doctors are afraid of drafts. If fresh air is good for sick people, it is surely good for well people. One reason for the great amount of consumption among women of the country is that they get no fresh air at all during the winter. There is no excuse for going without fresh air in the country. Anyone who has slept on a sleeping porch for a few weeks will never willingly sleep indoors again. Extra fuel and extra blankets cost less than medicine, doctors' bills, and caskets.

**Pure, abundant, and wholesome food.** Fresh air alone, however, will not keep a person healthy. Proper food is needed also. Country people have enough food, but often it is not proper food. There are more badly nourished school-children in the country than in the city. This is because city people eat a greater variety of food, and variety is necessary. The skin affection called pellagra is caused by a diet without variety.

The following are some of the principles of a proper diet: Vegetables and fruit are more important than meat. Fruit of some sort should be eaten daily, winter and summer. Lack of fruit may cause rickets and scurvy in children. Eggs and cheese may be used in place of meat. Cereals are a splendid food. At least 1 quart of milk a day should be allowed to each child in a family. Milk should be kept at a temperature of not over 50 degrees. Children contract tuberculosis through drinking milk from tuberculous cows, especially tuberculosis of the glands and joints, such as "white swelling," humpback, and hip disease. All milk for children, unless it comes from tuberculin-tested cows, should be heated, to kill the disease germs. This is called pasteurization. (See Chapter 13, "Teaching Children to be Healthy and Good.") Frying is the worst way of cooking food, and causes much of the indigestion so common in the country.

**Pure and abundant water.** Much less water per person is used in the country than in the city. Yet bathing is essential to health, and soap and water are the best disinfectants in the home. Money invested in a good, abundant water supply, is money invested in health.

The importance of drinking a great deal of water and of having it pure is very great. (See "How to Prevent Communicable Diseases," below, and Vol. III, Chap. 31, under "Water Supply.")

**Common-sense laws in respect to daily life.** What else besides air, food, and water is necessary to health? Plenty of sleep, proper clothing (especially suitable shoes), deep breathing, correct posture, regular meals, avoidance of alcohol and drugs and of the excessive use of tobacco, coffee, and tea.

FIG. 286. Insanitary, disease-breeding surroundings for a spring. (See Fig. 286.)

## How to Prevent Communicable Diseases

We have just spoken of ways to insure health. What is necessary to prevent sickness? A great many illnesses are catching. The spread of such diseases could be entirely prevented, if proper precautions were taken; and,

in this way, 800,000 lives could be saved in the United States alone each year.

All contagious, infectious, and communicable diseases are caused by germs. Such germs are given off by the sick person in various ways, and are carried from person to person in several fashions. Some germs are given off in the urine and bowel movements.

FIG. 287. If a spring is to provide the family water supply, its purity must be assured and then protected by concrete curb and clean surroundings.

**Typhoid fever.** This is especially true of typhoid fever. Typhoid germs will live in water, in running water, even in ice; but boiling water kills them. Any well or stream which receives drainage from a privy or cesspool, or which is otherwise contaminated by human excreta, may carry typhoid to people drinking the water. Some persons who had typhoid years ago, and some who never have had typhoid, may carry germs in their intestines. These people are called "typhoid carriers."

The fact that no one has yet been made sick by water from a certain well, will not prevent some one from catching typhoid from that well to-morrow. Privies should never be built to overhang a stream or to drain into it. Water for drinking purposes should not be used from a well which receives any surface drainage, nor from a stream, unless the water is boiled. The State of Pennsylvania has protected her water supplies from contamination since 1906, and in that time has decreased the number of people in every hundred thousand who die yearly of typhoid, from 55 to fewer than 18, thus saving thousands of lives and hundreds of thousands of dollars.

FIG. 288. The neglected, tumble-down, fly-infested privy is a too common source of widespread disease.

Typhoid germs live in milk and food also. Milk, therefore, should not be put into utensils washed in dirty water. Milking should not be done by any person who has recently had typhoid. All milkers should wash their hands thoroughly before milking. Milk and food for others should not be handled by a person ill of typhoid or diarrhea, or by a person taking care of any one having these diseases. Whole families have caught typhoid because the mother did both the nursing and the cooking.

**Flies as germ carriers.** Flies spread disease, especially diarrhea, typhoid, and tuberculosis. Flies walk in filth, collect germs on their hairy legs, and then spread the germs over food, milk containers, and on the baby's face. The fly walks about in the privy, over the sick baby's soiled diaper, or in the consumptive's spittle, and then over the food and in the milk. Flies should not be allowed to breed. The most dangerous fly, the common housefly, breeds chiefly in horse manure. It takes from 10 to 14 days to develop. The manure pit should, therefore, be screened and made flyproof. It should be emptied frequently, and the contents spread and dried. Before removal, the manure should be sprinkled with borax daily. This kills the fly larvae, and does not injure the manure as fertilizer.

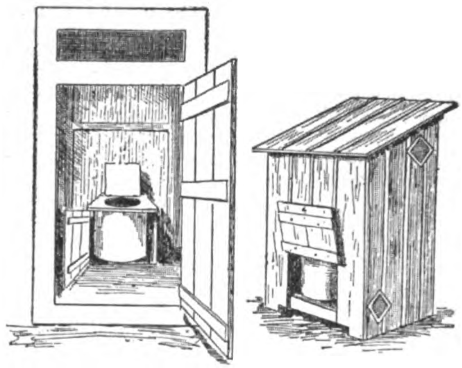


FIG. 289. Front and rear views of a privy within reach of any farm in simplicity and cheapness. It must be well built, however, tightly screened, and given frequent attention.

Every privy should be perfectly screened; all discharges of sick persons should be disinfected before being disposed of; and babies should be protected from flies with netting.

Twice as many babies were sick and died from diarrhea in a district in New York where screens and netting were not used as where they and their food were protected from flies.

**Discharges from the nose and throat.** The germs of other diseases are given off in discharges from the nose and throat. These diseases are tuberculosis of the lungs, pneumonia, bronchitis, tonsillitis, grippe, colds, and children's diseases, such as mumps, measles, chickenpox, whooping cough, scarlet fever, and diphtheria. It is not the scale from the rash that carries these diseases. The germ is in the "runny nose" and in the cough with which most of these diseases begin before they are recognized, and when they are most catching. These are serious diseases, and no child should be knowingly exposed to them. There were 6,000 deaths from whooping cough in the United States alone in 1916. These diseases have, too, very serious after-effects. Paralysis and heart trouble may follow diphtheria; deafness and kidney and heart troubles often come after scarlet fever; while a fatal pneumonia frequently succeeds measles.

Hygienic habits, which prevent the spread of these infections, should be practised, such as not kissing on the mouth, covering the mouth when coughing and sneezing, not spitting, and not sharing with any one towels, cups, spoons, pencils, candy, or gum. The quarantine (by which is meant confinement away from other people) of persons ill with these diseases, should be insisted upon by the whole community.

**Sexual diseases.** Other very serious contagious diseases which may be spread by the use of the same towel or cup are gonorrhea ("clap" and gleet) and syphilis, although these are usually sexually transmitted.

**Malaria.** Malaria is communicable. It is carried from a sick person to a healthy one by a mosquito. Malarial patients should be perfectly screened. Mosquitoes should be prevented from breeding. They take 11 days to develop, and breed only in stagnant water.

FIG. 290. This kind of back-yard is a favorite breeding place for flies, mosquitoes and the diseases they carry

Every one should take care not to allow water to stand in uncovered rain barrels, in cans, tubs, or elsewhere. The community should see to it that all swamps are either drained or covered with coal oil, for mosquitoes travel miles.

**Hookworm disease.** Hookworm disease, still common in the South, although much good work for its restriction has been done in recent years, is a serious malady. The worms are deposited in the soil in the bowel movements of persons affected with the disease, and thence enter the blood of healthy people who may happen to walk barefoot on the polluted soil.

**Trichinosis, bubonic plague, trachoma and pink eye.** Trichinosis is caused by a germ in pork that is not thoroughly cooked. Bubonic plague occurs mainly on the Pacific Coast, and is carried by the fleas on rats. Trachoma and pink eye are infectious eye diseases communicated by means of anything that has touched diseased eyelids.

## How to Prevent Diseases that are not Contagious

Much could be done to prolong life, if other diseases that are not contagious, such as cancer and Bright's disease, were discovered early. A yearly medical examination of all persons would save many lives. All children should be examined at least once a year. Much backwardness in school is due to some curable, unsuspected physical defect. It is estimated that more than one quarter of all country children have enlarged tonsils, and nearly one-half have decayed teeth. Rheumatism and neuralgia are often caused by decayed or dirty

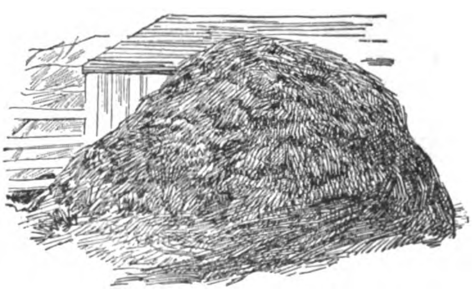


FIG. 291. The manure pile, unless rightly handled, is the breeding place of the house fly—now better known and feared as the "typhoid fly."

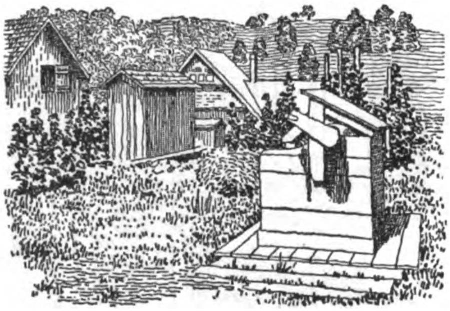


FIG. 292. Pollution of the water supply of these houses as the result of the location of the outhouses close to and above the well level, is almost certain.

teeth. A toothbrush should be used every morning and at night just before going to bed. A nourishing diet containing very few sweets is as necessary as the toothbrush to preserve the teeth. A healthy mouth, a healthy stomach, and general well-being depend upon the proper care and filling of the first, as well as the permanent set.

## What to do in Illness

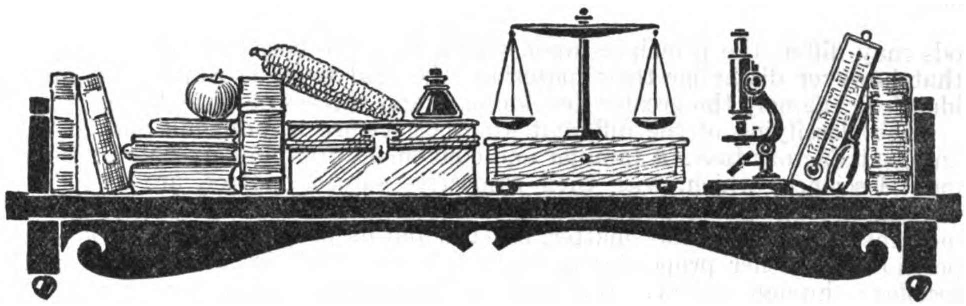
We have discussed rules of health, ways to prevent avoidable sickness, and methods of controlling other diseases. The next question is: When sickness occurs, what shall be done?

Immediate and excellent care should be provided. No one family can do this for itself. The whole community should work together to see that institutions are provided for such contagious and tuberculous cases as cannot be cared for properly at home, as well as institutions for the feeble-minded, epileptic, and insane. An association should be formed to provide domestic service in case of sickness, as well as maternity, visiting, and trained nurses, as has been done by the Dutchess County (New York) Public Health Association. Free school and dispensary treatment should be provided. It is a waste of money to spend school taxes to educate children who are not physically fit to be in school. Bad eyes, bad teeth, and diseased breathing passages should be corrected—free of charge, if necessary.

**Health officers.** A rural community needs, as much as any city, a full-time health officer. He should be responsible to the community for the registration of births and deaths, the reporting of diseases, the enforcement of quarantine, the provision of free vaccination against smallpox and typhoid, and of free nitrate of silver for use in the eyes of new-born babies, to prevent blindness. He should test cattle for tuberculosis, and milk-handlers for typhoid, and examine medically all school-children. He should see that only reputable doctors are allowed to practise in his district, and should enforce the laws against harmful patent medicines and traffic in drugs.

**Educational campaigns.** However, a health officer cannot accomplish much in an ignorant community. The only real way in which a community can be healthy is by educating everyone in it regarding health. Educational campaigns should be carried on by every possible agency — schools, churches, Granges, county fairs, newspapers, libraries, and fraternal organizations. The Town and County Nursing Service of the American Red Cross counts the educational work which it is doing in the homes and schools as of even greater importance than the relief it gives to the suffering. Insurance agents, visiting nurses, and cooking teachers can carry health education into homes. Such campaigns have saved thousands of lives throughout the country.

FIG. 293. The first taxpayers' county hospital in the world. Built in Washington County, Iowa, it provides a rural community with the same sort of advantages that city folk enjoy.



# FARM KNOWLEDGE

## PART III

## Science and the Farmer

EVERY human activity falls into one of two great divisions; either it is a science or it is an art. Science may be called knowledge arranged in a systematic manner; an art consists of the practical application of such knowledge in accomplishing some desired result. From another viewpoint we may say, in the words of an authority who knows both sides, "A science is a collection of facts based on definite, natural laws; it can be learned and taught by means of books. An art is the personal interpretation and use of such facts; it cannot be learnt from books but must be acquired by practice." On this basis, farming clearly represents the combination of both science and art.

Farmers have not always in the past been prompt either to recognize or to welcome this fact. They have, indeed, tended to set up a barrier between themselves—whom they liked to think of as thoroughly "practical"—and the scientists—investigators and teachers—whom they viewed as theoretical, visionary and unbusinesslike. As a result there has existed for a long time an unfortunate gap across which the really invaluable information that the scientists have been collecting and arranging was unable to go in order to assist the art of successful farm practice. Doubtless there have been many contributing causes other than the farmer's attitude. The scientists have not, perhaps, always been ready to go even half way for fear of lessening the dignity of their calling; their reports and conclusions were not always put in the form or language best suited to the needs of the layman; the sum total of real scientific farming knowledge was, after all, very limited; and the equipment needed for fully utilizing it was incomplete and only partially perfected.

Fortunately a new era of wider knowledge, broader understanding, greater sympathy, and greater coöperation and efficiency has arrived and is steadily extending its limits. Scientists are directing their efforts along lines in which the farmer needs the most assistance, and translating their discoveries into terms that he can use. Farmers, on the other hand, are looking to scientists for facts, and gradually developing a new appreciation of the value of experimental data and of advice based on theoretical principles.

The present part of this volume has been prepared with the idea of advancing this cause, of bringing still closer together the man who studies science and the man who uses it. It is not too much to say that however their meth-

ods may differ, the principles upon which they are based are the same; and that however dissimilar their materials, the goal towards which they aim is identical—namely the greater development and success of agriculture.

The classifying of the different kinds of science is a difficult and, at best, an unsatisfactory task. A familiar and convenient grouping gives us six fundamental sciences which, with their respective subject matter, are as follows: *mathematics*—numbers and their use; *astronomy*—the heavenly bodies, their movements, etc.; *physics*—matter, its laws and its properties; *chemistry*—composition and other properties of matter; *biology*—life in all its phases; and *sociology*—human society. But obviously even these groups are of necessity related and dependent one upon the other. Obviously, too, agriculture has its roots not in one or two, but in all these sciences. This fact alone should be sufficient to indicate not only its complexity, but also its importance and value in the world's progress.

The plan and purpose of FARM KNOWLEDGE do not permit a detailed survey of every branch of each science—nor would the farmer desire such a complete scientific treatise in a practical manual. The aim has been, therefore, to lay down in the simplest possible form the basic principles of a few of the sciences upon which farming more especially depends, and to include a few illustrations of some of the applications of those principles to practical farm operations and conditions. If the result is but to awaken in the minds of a few more farmers the thought that they, too, deserve the name of scientists; to give them a new, more acute idea of the dignity and depth of their vocation; and to enable them to work along new lines of systematic, carefully thought-out endeavor, it will have amply justified the effort taken to bring it about.—EDITOR.

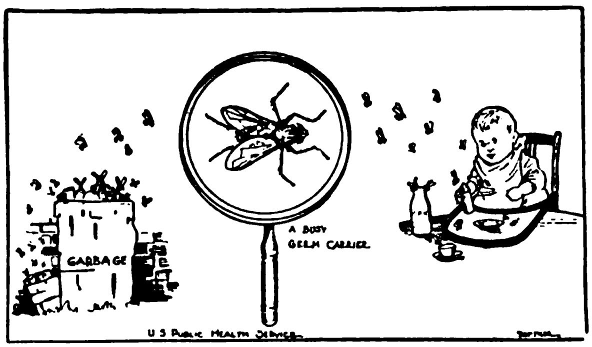



FIG. 294. Through science has come our knowledge of diseases, their causes, how they are transmitted, and how they can be controlled. Through practical application of this knowledge have come the methods by which we can keep ourselves and our communities healthy. This is but one illustration of the close relationship that exists in every phase and activity of farming, between science and art, knowledge and practice.

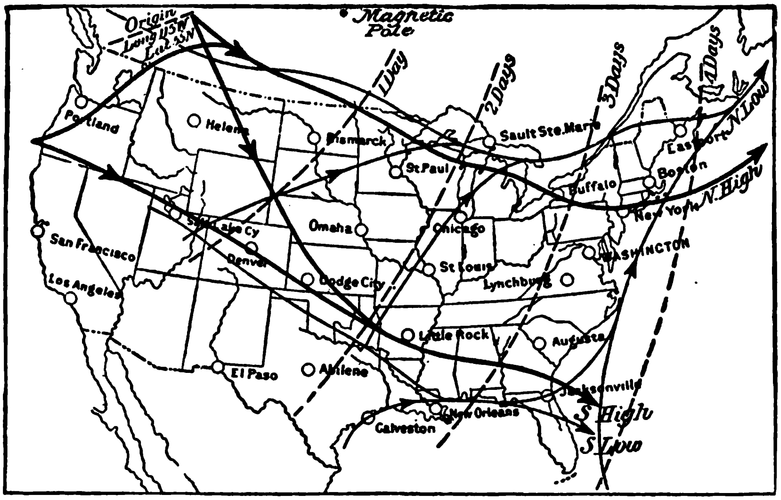



FIG. 295. Few people realize that storms tend to follow one general course. The heavy lines and arrows show the average tracks of high- and low-pressure areas over the United States. The broken lines show the average distance they travel each 24 hours. (See p. 355.)

# CHAPTER 16

# The Science of Physics

*By* PROFESSOR W. H. STEVENSON *of the Department of Agriculture of the Iowa State College, and Vice-Director of the State Agricultural Experiment Station, who introduces the subject and discusses it in its relation to soils and soil management;* PROFESSOR J. M. EVVARD *who treats of its relations with animal husbandry; and* PROFESSOR J. WARREN SMITH *who discusses those principles of physics that have to do with weather.*—EDITOR.

**WHAT physics is.** The aim of physics is to investigate and measure movements of or within materials, and to show how various forces operate upon or within these materials to produce certain effects; therefore, we may define physics as a science that deals with matter and energy.

Every farmer is interested in physics because he cannot conduct any operation on his farm that is not in some way based upon the principles of this science. The use of even the simplest tools, the plowing of the soil and the sowing and harvesting of the crops, bring into play many of the great underlying principles of physics. Thus, to understand almost any agricultural operation when considered from the standpoint of cause and effect, a knowledge of physics is fundamental. If it were not for our knowledge of physics, we would still be living in a primitive state, using the simplest forms of tools. During the last half century, the application of the principles of physics has given us our almost perfect farm implements. Moreover, physics has opened up a new field of investigation from the standpoint of the soil, and many of our most important soil problems have been solved because of knowledge gained through this science.

**MATTER** we generally think of as something that occupies space. However, this term can be understood more clearly if we consider a few of the general and special or individual properties of matter. A handsaw, for example, has length, breadth, and thickness. In addition to these general proper-

ties, it has special properties in that it is flexible, hard, and smooth. A portion of matter is called a *body*, while different kinds of matter, having definite properties, are called *substances*. A tin cup, a brick, and a shoe are bodies, while tin, clay, and leather, the materials from which these are made, are substances.

The following are a few of the properties exhibited by various forms of matter. They serve to indicate the complex nature of materials, and better enable the reader to appreciate the many factors which must be taken into consideration when dealing with any form of matter.

### Some Properties of Matter

**STATES**—Matter exists in three states, namely, gaseous, liquid, and solid. Gases have a definite mass, but neither size nor shape. Liquids have a definite mass and size, but not shape. Solids have a definite mass and both size and shape. All three of these have an important bearing upon agriculture, but more especially will the physics of solids and liquids be considered.

**MEASUREMENT**—As already mentioned, matter occupies space, or it has dimensions. The *three dimensions* of a body are length, breadth, and thickness. In order to measure these, certain arbitrary standards have been chosen. In the United States, Canada, and Great Britain, the system most commonly used is the *English*. In France, Germany, and other countries on the continent of Europe, the *metric* system is used. The standard of length for the English system is called the *Imperial yard*. One third of a yard is the *foot*, and one thirty-sixth of a yard the *inch*.

In the metric system the standard is called the *meter*. One meter is equivalent to 39.37 inches. One tenth of a meter is called a *decimeter*, one tenth of a decimeter a *centimeter*, and one tenth of a centimeter a *millimeter*. Often the *kilometer* is referred to, which is 1000 meters. For measuring distances over land in many of the European countries, the kilometer is used as a standard.

**POROSITY** or the property of having pores or spaces between the particles is common to perhaps all forms of matter. The soil, for instance, may absorb a large amount of water and still not change in volume. This is due to the fact that a portion of the soil mass is made up of pore space which gives the soil a porous structure. Many field soils have a pore space that equals one half of their volume.

**MALLEABILITY** is the property of some substances of being hammered or rolled without breaking. Gold, silver, lead, tin, and some forms of iron are malleable. In many cases it is desirable to have castings used on farm machinery which are malleable.

**HARDNESS** is the resistance which a body offers to being scratched or cut by other bodies. In making a cold chisel, the cutting edge is tempered or hardened that the chisel may be used to cut iron.

### The Mechanics of Solids

**FORCE** is some form of exertion which tends to produce or destroy the motion of mass.

**MASS** is sometimes defined as the quantity of matter in a body, or it is considered as the *weight* of a body. The earth's attraction for bodies is called *gravity*, and the force of gravity is spoken of as weight.

**Measurement of Mass.** The two standard units of mass are the *avoirdupois pound* for the English system and *kilogram* for the metric system. One sixteenth of a pound is called an *ounce*. The kilogram is equal to 1000 grams or about 2.2 pounds. One ounce is equivalent to 28.34 grams.

**WORK** is done when a force acts through distance or when motion is produced by the action of force. The unit of work is the *foot-pound*, which is the amount of work done in raising one pound through a distance of one foot. The rate of work is called *power*, and the unit of power most commonly used is the *horse-power*. A horse-power is work at the rate of 33,000 foot-pounds per minute. That is, if 33,000 pounds were raised through a distance of 1 foot in 1 minute, 1 horse-power of work would have been done.

**MACHINE** refers to a device for applying work. By means of machines various forces are changed and used to greater advantage. A machine must not be thought of as a source of work. In fact, the amount of work received from any machine is not as great as the amount put into it. There is always some force lost in overcoming friction. The ratio between the amount of work obtained from a machine and the amount put into it, is called the *efficiency* of that machine. Perhaps the most complicated piece of machinery in use on the farm consists of merely modifications of the simple machines. These simple machines are 6 in number: the *pulley*, *wheel and axle*, *inclined plane*, *wedge*, *screw*, and *lever*.

The pulley is a grooved wheel which is free to turn on an axle and over which a cord passes. A pulley affords no advantage except that of changing the direction of the power. In unloading hay with a hayfork, the horse must pull the entire weight of the fork and hay, and walk a distance equal to the height the load is raised. A combination of two or more pulleys is called a *block and*

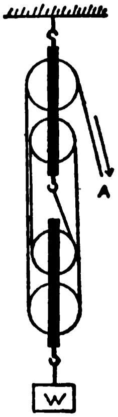


FIG. 296. Double pulley

*tackle.* In Fig. 296, in which 2 pulleys are contained in each block, the power is applied at A, to raise the weight W. This arrangement makes possible the lifting of heavy weights with only a small amount of power applied. The law or principle governing such a system of pulleys is: *The power applied is increased as many times as there are pulleys in both blocks.* For example:

What weight can be raised with a block and tackle which has 2 pulleys in each block, by applying 150 pounds pull to the free end of the rope? *Answer:* 150 × 4 = 600 lbs.

If the weight is known, and we wish to find how much of a pull will be needed, then: 600 ÷ 4 = 150 lbs.

**The wheel and axle** (Fig. 297) is only a modification of the lever and acts according to the same general laws or principles. The center of the axle represents the fulcrum, the radius (one-half the diameter) of the axle corresponds to the short arm, and the radius of the wheel to the long arm. *The power applied to the wheel is increased as many times as the radius of the wheel is times greater than the radius of the axle.* For example:

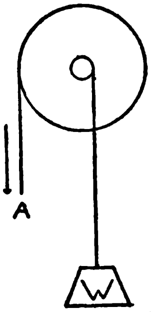


FIG. 297. Wheel and axle

A wheel 50 inches in diameter has a rope passing over it, upon which 100 pounds pull is exerted. What weight, attached to a rope winding around the axle which is 5 inches in diameter, can be raised?

5 : 50 : : 100 : ?
50 × 100 = 5000
5000 ÷ 5 = 1000 lbs. *Answer:*

Should we desire to find the power that it will take to raise 1500 pounds by the above wheel and axle, then:

5 : 50 : : ? : 1500
5 × 1500 = 7500
7500 ÷ 50 = 150 lbs. *Answer.*

One form of *wheel and axle* in use on the farm is the derrick. The rope on which the work is done is wrapped about the axle, while the wheel in most cases is connected to a second axle by spur gears. A crank is attached to the second axle and answers the same purpose as a wheel. This double arrangement makes the machine more efficient.

**The inclined plane** is an even, sloping surface at any angle between the horizontal and vertical. It may be used for rolling barrels onto a platform (Fig. 298). The law or principle governing the inclined plane is: *The power applied is increased as many times as the length of the incline is greater than the height.* For example:

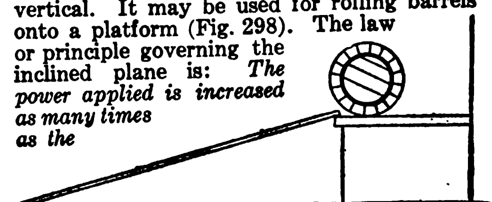


FIG. 298. The inclined plane

How heavy a barrel can a man roll onto a platform 3 feet high, by means of a 9-foot plank? This man finds that he can just lift 225 pounds from the ground onto the platform. *Answer:*

He can roll onto the platform then,

3 : 9 : : 225 : ?
9 × 225 = 2025
2025 ÷ 3 = 675 lbs. *Answer.*

Since the plank is 3 times longer than the height of the platform then he will be able to roll onto the platform 3 times as heavy a weight as he could lift.

If we know the length of the plank, the height of the platform and weight of the barrel, and wish to find the power necessary to roll the barrel up the plank, then

3 : 9 : : ? : 675
675 × 3 = 2025
2025 ÷ 9 = 225 lbs. *Answer.*

If we have the weight of the barrel, amount of power and height of the platform, and wish to know how long a plank to use, then

3 : ? : : 225 : 675
675 × 3 = 2025
2025 ÷ 225 = 9 feet

On the other hand, if we have the weight of the barrel, the pounds of power and the length of the plank, and want to find how high the weight may be raised, then

? : 9 : : 225 : 675
225 × 9 = 2025
2025 ÷ 675 = 3 feet. *Answer.*

A good illustration of the inclined plane is found in the tread mill, which consists of an endless apron passed over rollers at each end of the platform. Power is derived from a pulley which is placed upon the axle of one of the rollers.

**The wedge** is used in breaking open logs (Fig. 299) or large blocks of wood, and proves to be a most valuable though simple machine. The force acting upon the wedge is generally applied by heavy blows with a maul. The result is that the wedge, which is nothing more than a double inclined plane, breaks the log apart.


FIG. 299. The wedge

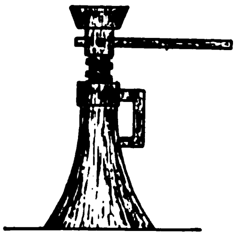
Because of the large amount of friction between the wedge and the material through which it is working, problems dealing with this simple machine are very difficult to compute. Neglecting friction, the following general principle governs the action of the wedge.

*The power applied is increased as many times as the length of one side of the wedge is greater than ½ the thickness of its head.*

If a wedge were 12 inches long and 4 inches across the head, then it would exert a force 6 times greater than the power applied; 12 inches divided by ½ the width of the head or 2 inches, equals 6. This, of course, only applies where friction is not considered.

**The screw** is a modification of the inclined plane, as may be seen by observing the threads which wind spirally around the cylinder. Familiar uses of the screw are found in the lifting jack (Fig. 300), the copying press and the bench vise.

**The lever** in its simplest form is a bar turning upon a point called a fulcrum (Fig. 303). The parts of the lever on each side of the fulcrum are the arms. The law or principle by which the lever acts is as follows: *The power*



*applied is increased as many times as the power arm exceeds the weight arm.* In the form of a proportion this would be: *the length of the weight arm is to the length of the power arm as the power is to the weight.* For example:

Fig. 300. The jackscrew

What weight can a man, weighing 175 pounds, raise with a lever 12 feet long, the fulcrum being 2 feet from the weight, and 10 feet from the power?

$2 : 10 :: 175 : ?$
$10 \times 175 = 1750$
$1750 \div 2 = 875$ lbs. *Answer.*

It will be seen that for every pound of power applied, 5 pounds of weight are raised. This is because the power arm is 5 times as long as the weight arm.

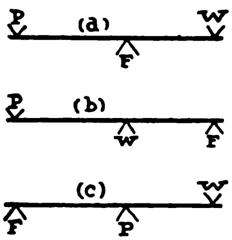



Fig. 301. The three classes of levers. P—power; F—fulcrum; W—weight.

There are three classes of levers as shown in Figures 301 and 302, many examples of which may be found about the farm. The pump handle represents a lever of the first class; the horse sweep is one of the second class; and the harness-maker's vise employs a lever of the third class.

From the foregoing it can be seen that before any satisfactory piece of machinery can be made, careful attention must be paid to the various properties of the materials which are to make it up. The weight of the materials, their porosity, hardness, malleability in many cases, and many other physical properties are studied. In addition to this, the different forms of machines are considered and attention is given to where they may be used to best advantage. Thus, if it were found that the lever would give the greatest efficiency at some place in a corn planter, it would be more desirable to use that type of simple machine than some other type. Often a single implement involves the use of several simple devices and thus a complicated machine results.

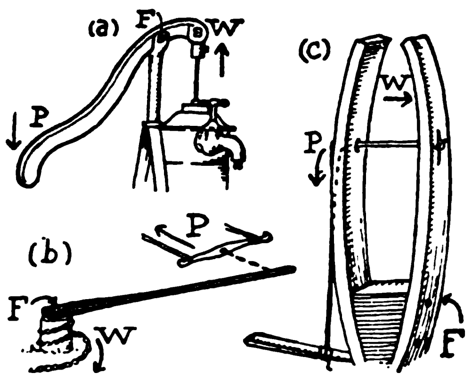



Fig. 302. Common farm machines illustrating the classes of levers shown in Fig. 301: *a* is a common pump handle; *b* is a horse sweep in which the drag of the chain around the post is the weight; *c* is a harness maker's vise in which the foot lever squeezes the jaws together in spite of the wedge which tends to hold them apart.

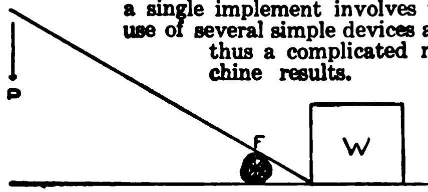



Fig. 303. The lever in its simplest form

## The Mechanics of Fluids

**SURFACE TENSION.** The surface of a liquid differs greatly from the interior. It acts like a stretched membrane, and it is this surface action or *tension* that causes small quantities of water such as raindrops, to assume a spherical form.

**CAPILLARY ACTION.** Surface tension plays an important part in the rise of water in tubes of small bore. When one end of a very small glass tube is placed in water, the water passes up into the tube (Fig. 304). The smaller the tube, the farther will the water pass upward. In this case, the attraction of the glass for the water is greater than the water for itself. When a solid attracts a liquid in this way, the liquid wets it, and rises. This rising of water in the manner explained above is called *capillary action.* Oil rises in a wick, water in a sponge, ink in a blotter, and water in the soil by capillarity. Capillary water, or the water moving upward in the soil, is the only water used by plants. Therefore, the common field crops would not grow if capillary action did not take place.

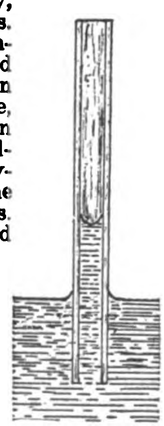


Fig. 304. Glass tube thrust into a liquid to show how the latter rises inside it by force of capillary action.

## Heat and Cold

If one touches a stove in which there is a fire, the stove feels *hot;* if one touches a piece of ice, it feels *cold.* In the first case, the stove feels hot because it gives heat to the hand. In the second instance the ice feels

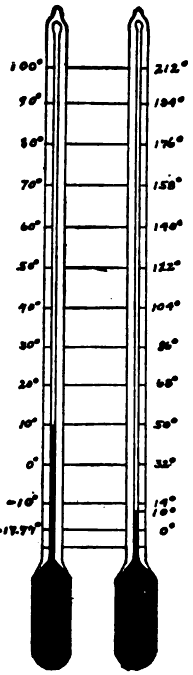



FIG. 305. Thermometers graduated according to the Centigrade (*left*) and Fahrenheit (*right*) scales. The mercury is at 10° above zero in each case.

cold because it *takes heat from the hand.* When hot water is poured into a cold pan, the pan becomes warmer and the water cooler. This is due to the fact that the heat has passed from the water into the pan. This continues until the two are at the same temperature.

**TEMPERATURE** is a measure of the degree of hotness of a body for which purpose the mercury-in-glass *thermometer* is usually employed. This type of thermometer is based upon the fact that mercury expands when heated, a portion of it passing from the bulb up into a tube of very small bore. When the mercury is cooled it contracts and returns to the bulb. The thermometer with the *Fahrenheit* scale is the one commonly used in English-speaking countries. The freezing point on this scale is 32 degrees above zero and the boiling point 212 degrees above. In scientific work, another scale called the *Centigrade* is used, in which the freezing point is zero, and the boiling point 100 degrees above zero. The thermometer readings are indicated by placing the letter of the scale name after the degrees. For example, 10° F. and 10° C. mean 10 degrees above zero on the Fahrenheit and Centigrade scales respectively (Fig. 305). In many places, where the temperature goes below—38.8 degrees C. or the freezing point of mercury, alcohol is used in place of mercury in the tube.

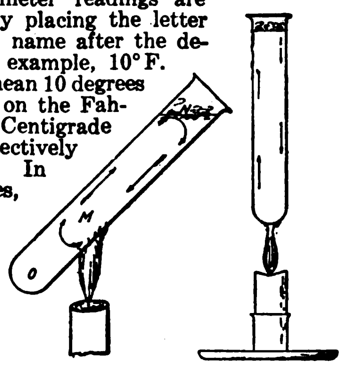



FIG. 306. Hot-water circulation. In the test tube at left, the water is cool at O and hot at M; some evaporates at N, the rest returning to be reheated. The same takes place in the other tube, the hot water rising along one side and the cooler descending on the other.

**MEASUREMENT OF HEAT.** The amount of heat gained or lost by a body when its temperature changes, is measured in terms of *calories.* The calorie, or unit of heat used in connection with the metric system, is the amount of heat necessary to raise the temperature of 1 gram of water 1 degree Centigrade. Heat is a form of energy, and the steam engine is nothing more than a device for transmitting heat energy, stored in the form of steam, into mechanical motion.

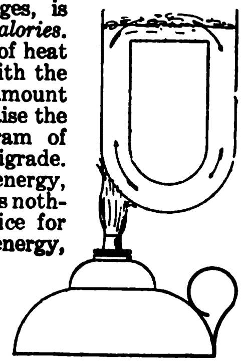


FIG. 307. Hot-water circulation by connection in a continuous tube. The greater weight of the cool water in the right arm increases the rate at which the warmed water rises in the left arm.

**EXPANSION.** In connection with the mercurial thermometer, it was mentioned that the mercury expanded when heated, and contracted when cooled. It is a familiar fact that solids *expand* when heated, and *contract* when cooled. The iron rails of the railroad are laid with a space between the ends to allow for expansion. In building sidewalks, joints should always be left at various places to allow for expansion of the concrete. In removing a glass stopper from a bottle, heat the neck of the bottle with a burning match and it will expand, thus releasing the stopper.

**EVAPORATION.** When water is heated to the boiling point, a change takes place and the water passes from the liquid to the gaseous state. This change involves what is known as *evaporation.*

**DISTILLATION.** In making absolutely pure water, the water is boiled, and the steam given off is passed through a pipe or tube surrounded by cold water. The steam, coming in contact with the walls of the cold tube, (A, Fig. 308), *condenses* or again assumes the liquid form. This process is called *distillation,* and by this means water free from vegetable and animal matter may be obtained.

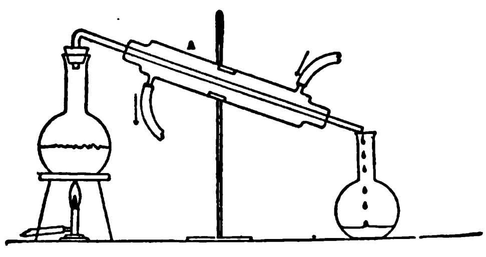



FIG. 308. Simple distillation apparatus. Steam from the flask is condensed when passed through the cold-water tube A.

# THE PHYSICS OF THE SOIL

DAY after day, during many centuries, the rock masses which originally covered the entire surface of the earth have undergone many changes. Gradually this rock material has been acted upon by various agencies, and as a result, gravels, sands and soils have been formed.

Among the many agencies at work in breaking down the various rock materials, may be mentioned the wind, water, ice, temperature, plants, animals and bacteria. The process of breaking down rock and the gradual change to form soil, is called weathering. Soil is but small pieces of rock with which has been admixed organic matter, namely, small particles of decayed plant and animal life. Many of the agencies of rock decay or weathering are in action at the same time, and great changes are brought about upon the earth's surface during a period of only a few years. In this study we are chiefly concerned with the physical agencies of weathering.

## Agencies of Rock Decay and Soil Formation

**WIND** in passing over the land picks up many fine particles of soil and sand. When driven against the surface of rocks, often with great force, these gradually wear away the rock. In this way rock masses are slowly broken down into soil.

The wind also transports soil particles from the place where they were originally found, to distant localities. Soil thus carried and deposited by the wind is called *loess* soil; great areas of it are found in the Mississippi Valley and in southwestern United States.

**WATER** is one of the most important agencies not only in wearing away rock, but also in transporting the weathered material to other places. *Erosion*, or the wearing away of the land by water, is a serious menace to agriculture in practically every part of the country. Often in a single field many acres are rendered useless by the destructive action of water. This problem of erosion does not have any direct bearing upon rock disintegration, but it shows how very destructive water may be. Water has still another effect upon the distribution of soil, in that it has the power of separating a soil mass into its various sized particles. In this way the finest particles, as silt and clay, are often laid down in very compact deposits known as *bottomland* soils.

FIG. 309. Erosion, one of the most effective agencies in both soil making and soil destroying, is an illustration of the working of physical laws.

The continued beating of rain, laden with dust particles, against the surface of rock, has a gradual wearing effect. This action may be observed over a period of years in localities where boulders are common.

**PLANTS AND ANIMALS.** Many of the simple plants such as lichens and mosses grow on the surfaces of rocks. Dust settles out of the air and collects about these plants, thus providing a foothold for other plants. Seeds of trees are blown into such accumulations of soil, and when conditions are favorable, the seeds germinate and trees are produced. The tree roots find their way into the rock crevices and, increasing in size, gradually break the rock apart. Plants play another rôle in soil formation in that they send their roots down through the soil; when these roots decay, the organic matter content of the soil is increased. This distribution of organic matter through the soil by the growth and death of plant roots is of great importance in making soils fertile.

Earthworms in passing through the soil open it up, thus providing better circulation of air and the freer movement of water. Gophers, moles, ground squirrels and other rodents have an effect similar to that of earthworms, except that their action is more pronounced.

**TEMPERATURE.** Rocks are made up of a collection of minerals which, when heated, do not all expand at the same rate. Due to these differences in expansion, many particles are broken from rock surfaces when they are heated. It is a familiar fact that large rocks may be broken by building a fire about them, getting them very hot, and then throwing cold water on them. A similar action, only on a smaller scale, takes place when rocks become heated by the sun's rays during the day, and then cool off at night. This is especially true during the winter.

**ICE.** In the centuries that have passed, large bodies of ice in the form of glaciers moved down across a portion of our country

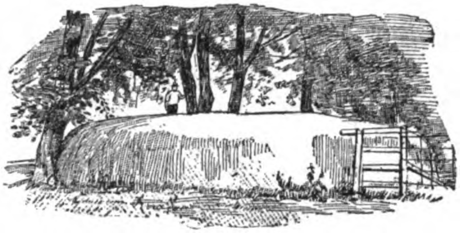


FIG. 310. Physics deals with forces—ranging all the way from those powerful enough to move this glacial boulder, to that with which a bacterium moves through the blood stream.

like a giant river. As these glaciers passed over the earth's surface, they ground up the rock beneath them. When the ice melted and the glaciers receded, all the rock which was ground up was distributed over the area covered by the body of ice. Soils formed by the movement of glaciers are called *drift* or *till* soils. They are fairly well supplied with the essential plant-food elements. The surface of the land now occupied by these drift soils varies from level to broken or abrupt.

BACTERIA. In addition to the above physical agencies, bacteria have an important part in the formation of soils. Bacteria are very small living plants. They are so small that it takes about 35,000 of them placed end to end to measure an inch. Bacteria multiply very rapidly and are present in most soils in exceedingly large numbers. They are important agents in soil formation in that they act, not only upon the rock particles, but also upon organic materials incorporated with the soil. When corn stalks, straw and stubble are plowed under, bacteria act upon them and gradually break them down into very simple compounds. In a short time we are no longer able to distinguish the different kinds of plants which have been turned under.

## Size and Arrangement of Soil Particles

TEXTURE. Soil particles vary in size from gravel to those so small they cannot be seen with the naked eye. The texture of the soil refers to the size of the particles, the following table serving to indicate the differences in the texture of soils.

| | |
|---|---|
| Very coarse sand | 2.000 to 1.000 mm.* |
| Coarse sand | 1.000 to 0.500 mm. |
| Medium sand | 0.500 to 0.250 mm. |
| Fine sand | 0.250 to 0.100 mm. |
| Very fine sand | 0.100 to 0.050 mm. |
| Silt | 0.050 to 0.005 mm. |
| Clay | 0.005 to 0.000 mm. |

* 1 millimeter, written mm., equals about 1/25 of an inch.

Thus the texture of a soil may be fine, medium, or coarse, depending upon the size of the particles composing it. *Sandy* soils are those in which sand predominates. *Clay* soils are those in which the largest percentage of the particles is clay. A *loam* soil is one which contains about one-half silt and clay, and the other half sand. The texture of the soil is of great importance because it is one of the main factors in determining the value of land from an agricultural standpoint. We can understand how, through the ages that have passed, a rock may be broken down into particles of various sizes. However, under normal conditions on the farm, texture can be little affected. A clay soil remains a clay, and a sand remains a sand. The only way we could vary the texture would be to mix two soils of different textures. This change is not practical in the field, of course, and is seldom made except on a very small scale as in a greenhouse bench or in a hotbed.

STRUCTURE. Structure refers to the arrangement or grouping of the soil particles. In many soils the texture is so fine and the particles fit so closely together that the soil is very compact. On the other hand, some soils have particles so large and loosely arranged that drainage is excessive and the soil undesirable from an agricultural standpoint. However, in normal soils, the particles vary in size, the small intermixing with the large. Loam may be considered as one of the most desirable of soils, since in it the particles are so arranged as to allow adequate drainage, and at the same time sufficient water is retained for plant uses.

**Improvement of structure.** The farmer can change the structure of the soil by the addition of organic matter, since the physical condition of the soil is dependent in a large measure upon this material. This change may be brought about by growing and turning under such crops as clover, alfalfa, sweet clover, and other green manure crops like rye and buckwheat. In addition to this, corn stalks, stubble, and straw serve to increase the organic matter content of soils and may, therefore, improve their structure.

**Tillage.** The various operations of tillage, which include plowing, subsoiling, harrowing, rolling, and cultivating serve to bring about a change in structure by rearranging the soil particles. The exact nature of the results produced by these operations, however, depends largely upon the moisture condition of the soil. If soil is plowed or cultivated when it is too wet, it soon bakes and

FIG. 311. Stones removed from a field of glacial till soil. They have an affect on the quality and condition of the soil and the ease with which it is handled.

forms clods. On the other hand, if soil is plowed when very dry, it turns over in large lumps and is not well pulverized.

**Plants.** As plant roots grow outward and downward and pass between the soil particles, the soil is opened up and a freer circulation of air takes place. One of the beneficial effects derived by growing a crop such as alfalfa, is that its root system extends far down into the soil, thus opening it up to a great depth. Rodents and earthworms also burrow through the soil and improve the structure by mixing the various soil constituents.

**Lime.** During the past few years many farmers have made applications of lime to their soils in order to neutralize the acid present. While this is one of the main reasons for applying lime to soils, there is still another equally important one, namely, the effect produced upon the structure of the soil. When lime, especially burned lime, is used, flocculation or the bringing together of the soil particles in the form of granules, is brought about. It is generally true that soils which contain lime are in better physical condition than soils of the same texture which do not contain this material in fair amounts.

**Variation in water content** may bring about a notable change in the structure of soils. If a soil contains a large amount of water it tends to become puddled. This is very undesirable from the standpoint of crop production. The proper installation of drains is the most satisfactory means of doing away with a surplus of soil water.

## Soil Water

Water in the soil has four main functions to perform. (1) Green plants have the power of manufacturing a large amount of plant food. In this process of food manufacture, water is used directly. (2) Water makes the plant food elements in the soil soluble and puts them in such form that they may be taken up by plants. (3) Plants require a large amount of moisture to keep them rigid, and this is all taken up from the soil through the plant roots. If more water passes from the plant by way of the leaves than is taken up by the roots, the plants wilt. Thus a sufficient supply of water in the soil is essential at all times. (4) Water is necessary for the multiplication and activities of bacteria.

**KINDS OF SOIL WATER.** Under normal conditions of rainfall, there are three kinds of water in the soil, namely, hygroscopic, capillary, and gravitational. The amount of each of these forms that is in the soil depends upon rainfall, texture, and structure of the soil, tillage, drainage, organic matter, and many other factors. The productive power of a soil depends very largely upon its water content and the ability of crops to take up moisture from the soil.

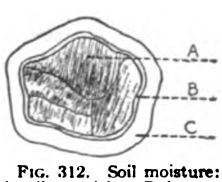


FIG. 312. Soil moisture: *A* soil particle; *B* hygroscopic water; *C* capillary water (greatly enlarged).

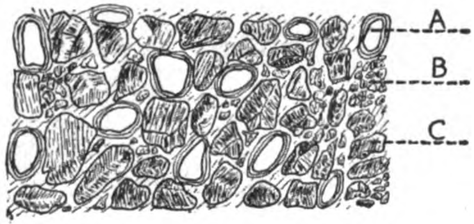


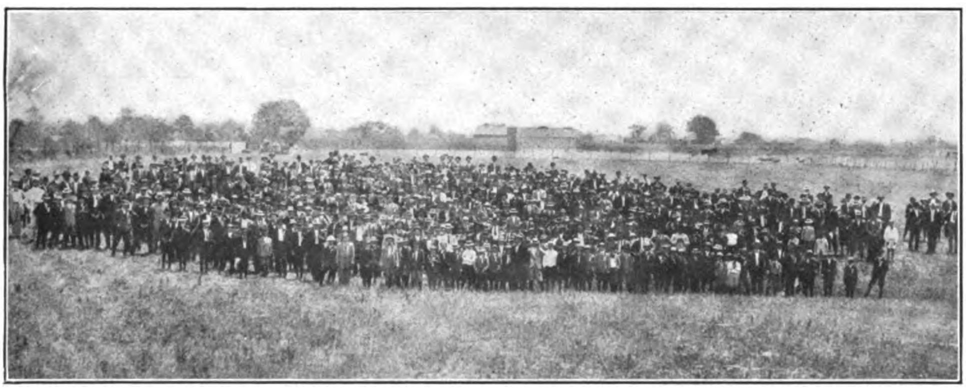
FIG. 313. Soil structure: *A* pore space; *B* granule composed of silt and clay particles; *C* sand or other larger soil particle.

*Hygroscopic water* is the moisture in the soil surrounding the soil particles in the form of a very thin film. This type of water is lost only when the soil is oven dried. In other words, under field conditions, hygroscopic water is always present. However, this water is not available to plants because the roots are not able to take it up. It is a well-known fact that if we sow winter wheat in dry soil, and there are no rains following the seeding, the seed does not germinate. If, however, we take some of the dry surface soil from this field and heat it in an oven, it is found to contain water. This water which is given off is called hygroscopic water, and, as noted, it is of little importance in the growth of plants.

*Capillary water* (p. 340). We have often noticed that as fast as oil burns from a lamp, more oil is supplied by an upward movement through the wick. If we examine the wick carefully we find it is made up of porous material through which the oil is carried upward by capillary action. In the same way water rises, or moves sidewise, in the soil by passing through the small pore spaces between the soil particles. This type of water is called capillary water and is lost when the soil is air-dried.

*Gravitational water* is that water which passes down through the soil by force of gravity. This kind of water passes off as drainage water, or runs off, and consequently is not available for plant use. If drainage conditions are not satisfactory and gravitational water is present, our ordinary field crops as corn, wheat, and oats, do not make a satisfactory growth. It is to the farmer's advantage then to keep the soil free from this type of water. There are some crops, however, as rice, which do make use of some gravitational water, thorough drainage of the fields being then undesirable. Hygroscopic and gravitational water cannot be used by our common field crops, capillary water being the only type that is available for the use of plants.

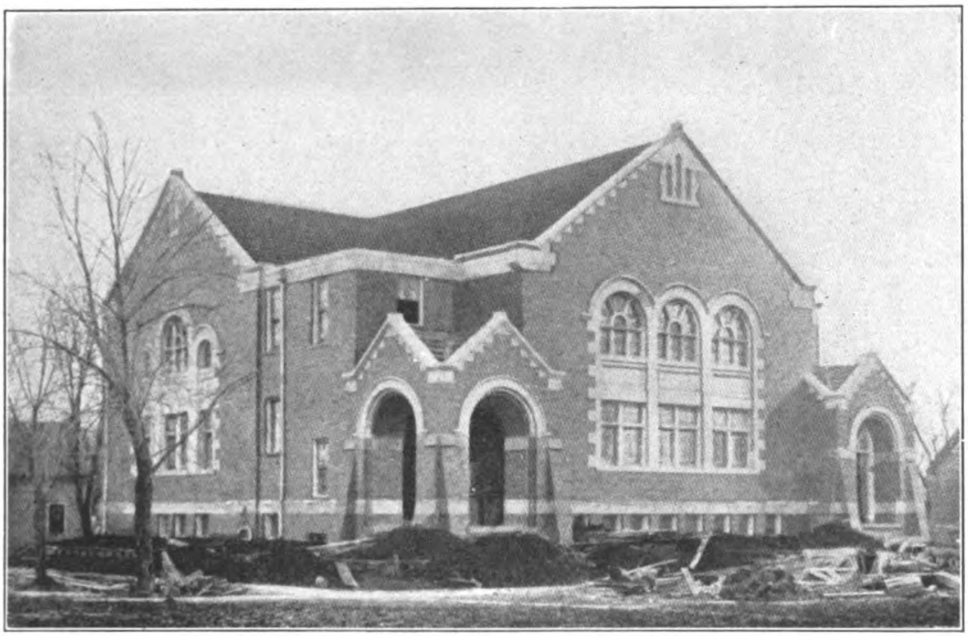
Jerry Moore, one of the pioneers in Corn Club work, and the 228 bushels and 3 pecks that he raised on an acre. Did he know a good thing when he saw the club movement coming his way?



These boys, members of one Louisiana Corn Club visiting their State Experiment Station, would agree that he did; and in doing so they would express the feelings of a million or so

As One of the Many Results of Corn Club Extension Work, the Yield of Corn in Several Sections Has Been Increased 100 Per Cent or More. (U. S. Department of Agriculture)

A modern neighborhood church in Missouri



A building erected in an Iowa farming community to shelter under one roof, two or more religious denominations, a library and a gymnasium

THE COUNTRY CHURCH SHOULD BE THE CENTRE OF SOCIAL AND EDUCATIONAL, AS WELL AS RELIGIOUS, ACTIVITIES; IT SHOULD TAKE PART IN THE EVERY DAY LIFE OF ITS COMMUNITY

**MAINTAINING AND INCREASING THE SOIL WATER.** Irrigation is practised in many areas where there is not a sufficient amount of capillary water present in the soil to permit of the growth of plants. In the western part of the United States, thousands of acres of arid or semi-arid land have been made productive by irrigation water.

**Mulches.** In humid regions, or those receiving more than 20 inches of rainfall annually, the main problem in soil management as a rule is to conserve the moisture in the soil. This is accomplished chiefly by means of mulches. There are two general classes of mulches, the *foreign* and *natural*. The foreign mulch consists of such materials as straw, leaves, and manure scattered over the surface of the soil. The natural mulch, on the other hand, consists of the upper zone of the surface soil kept open and loose by thorough cultivation. Both types of mulches have the same function, namely, to prevent the loss of capillary water from the soil.

When a farmer cultivates his corn, he usually does so with the idea in mind that the principal object is to destroy the growth of weeds. However, in many cases one of the chief purposes in cultivating the soil is to conserve the capillary water.

If the soil upon which corn is growing is allowed to remain in a compact condition and is not cultivated from time to time, enough water may be lost to interfere seriously with the growth of the crop. But when the cultivator shovels pass through the soil, they break apart the soil granules and make the surface soil loose and dry. When the surface soil is in this condition, the upward movement of water through this zone is practically stopped and evaporation is reduced to a minimum. The mulch made by the cultivator usually varies in depth from 2 to 3 inches, depending upon the condition of the soil and the kind of cultivator used.

For corn, a type of tilling machine known as the "surface cultivator" is often used. The part of the implement which stirs the soil consists of flat blades which pass along just under the surface. This implement is designed to make an effective soil mulch without pruning the corn roots. The shovel type of cultivator often seriously injures corn because the shovels cut off the feeding roots of the young plants.

To be most effective, a mulch should be kept dry and loose. The only feasible way to maintain a mulch in this condition is to renew it after each rain. Moisture is thus conserved, and the soil warms up more quickly than when large amounts of water evaporate from the surface. Evaporation is always a cooling process.

**Fallowing.** In some states where the rainfall is exceedingly light, fallowing is practised to retain moisture in the soil. When this system is practised, a crop is usually grown only every other year. When a fallow system is followed, a portion of the farm is cropped and another portion is carried through the summer without a crop. The latter area is harrowed or cultivated after each rain, or oftener, to form and maintain a mulch. As a result of this practice, one crop gets the benefit of two years' rainfall.

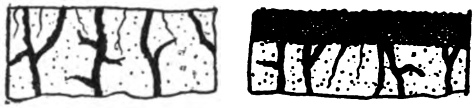


FIG. 314. In a compact soil (*left*) moisture rises through cracks, wormholes, etc., by capillarity action and is lost by evaporation. Tillage or any sort of mulch (*right*) destroys the capillary tubes and thereby conserves the moisture.

In humid sections, the summer fallow is not in general use but is sometimes employed to increase the moisture content of the soil for some crop such as alfalfa that is to be seeded in the fall. In this case the alfalfa has the benefit of the stored rainfall that fell during the summer and fall, and as a result, a stand is more likely to be secured.

**Organic matter.** Organic matter which is thoroughly decomposed has great capacity for holding water. Such material is very porous and acts much like a sponge. In addition to having a direct effect upon the water-holding power of soils, organic matter tends to hold soil particles together in the form of granules or crumbs. When a soil possesses this granular structure, it is usually in an excellent physical condition.

**Fall plowing.** One of the beneficial effects of fall plowing is the conservation of water in the soil. The surface soil which is turned over acts as a mulch and prevents the loss of large amounts of water during the fall and winter months. In the spring, the land should be disked as early as possible without injury to the soil structure, to provide a mulch and retain any moisture which may have entered the soil due to winter rains or the melting of snow.

**Decreasing soil water.** Two general methods used for decreasing the amount of soil water are: (1) the installation of suitable drains, and (2) rolling the land.

**Drainage.** Perhaps the most effective means of decreasing soil water is by drainage. This consists of opening up channels in the soil through which surplus water may run off by the force of gravity. The tile drain is preferred above the open ditch because its use insures more thorough drainage of the soil, less waste of land, and more regular fields. The open ditch is undesirable since portions of the fields through which such a drain passes are worthless for the growing of farm crops, and, moreover, open ditches usually cut up the farm into irregular fields that are difficult to cultivate.

**Rolling.** In the spring when there is not a

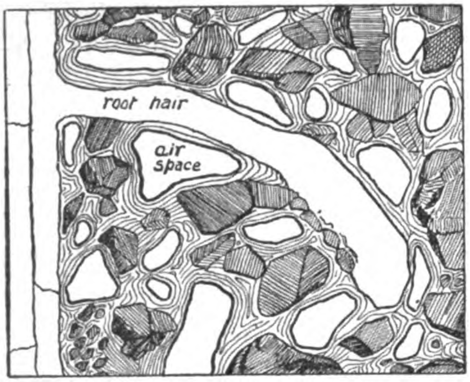



FIG. 315. Part of a root, showing root hair extending among the soil particles which are surrounded by water films. Note air spaces. (All greatly enlarged.)

sufficient amount of water in the soil, and when the seedbed is very dry and loose, rolling is sometimes practised. The surface soil is compacted by this operation and the capillary water moves more rapidly to the surface. Usually the harrow is used a few days following rolling, in order to establish a mulch and prevent too great a loss of water.

## Soil Air

The amount of air present in a soil is determined largely by the water content of the soil mass. When the water increases in amount, a proportional decrease takes place in the air present. Air is as important for the growth of crops as it is for animals.

If a soil is poorly drained, and contains a large amount of water, crops suffer because of a lack of air and, often, seeds fail to germinate. It is also necessary for the life of many beneficial forms of bacteria that live in the soil. Some of these bacteria, it will be remembered, break down plant residues in the soil and change them into simple compounds which may be taken up by roots of growing crops. Other bacteria, which live in the small nodules on the roots of such crops as alfalfa and clover, have the power to secure nitrogen from the air and fix it in compounds that may be used by growing plants. This process is called *nitrogen fixation*. We find that if there is not an ample supply of air in the soil, these nitrogen-fixing organisms cannot carry on their very important work. The amount of air in a soil is determined by its texture, structure, and its content of organic matter and water.

**Texture.** Under ordinary field conditions, soil of fine texture such as a clay, contains the largest amount of air space. On the other hand, the air spaces in a sandy soil are larger, and as a result, air moves more freely in this type of soil than in clay. When air circulates through the soil rapidly, the soil moisture tends to decrease in amount. In a region of low rainfall and high temperatures, this loss of water should be guarded against at all times.

**Structure.** The structure of a soil changes from time to time depending chiefly upon the action of water and the presence of organic matter. The formation of soil granules tends to increase the amount of air which is present in a soil. Plowing, disking, harrowing, and cultivation all help to change the structure and increase the amount of air in the soil. By removing the gravitational water from a soil, conditions of aëration are improved. Since the amount of air in the soil increases with the amount of organic matter which the soil contains, applications of farm manure and green manure aid materially in soil ventilation. The volume of air in a soil is decreased by rolling or packing. These operations are common chiefly in the West where dry-land farming is practised.

## The Heat of the Soil

Heat has an important relation to the germination of seeds. For instance, a favorable temperature for the germination of seeds of most common field crops is about 80 degrees Fahrenheit. Again, the multiplication and activities of the desirable kinds of soil bacteria are influenced by the temperature of the soil. The amount of heat in the soil determines to a certain extent the rate at which plant food goes into solution. The warmer the soil the more readily is plant food dissolved. A knowledge of the functions of heat

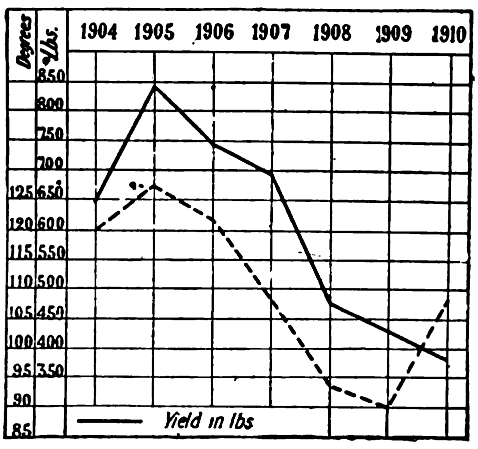



FIG. 316. Chart showing relation of the potato crop to the temperature of the soil at planting time, as indicated by a series of experiments in Russia. The solid line and second column of figures show the variations in yield; the broken line and first column give the total temperature of the soil for the ten days preceding the planting of the seed. (International Institute of Agriculture.)

and the means of temperature control is important since the farmer can, in a measure, control this important factor in crop production. The principal sources of heat in the soil are the direct rays of the sun, and decaying organic matter.

The sun's rays either directly or indirectly make it possible for soils to support plant life. Soils have the power of taking heat from the sun's rays, and the darker the soil the more readily is this heat absorbed. Dry soils warm up more quickly than wet soils, because in the case of dry soils little heat is used in warming and evaporating water. Heat may be carried into the soil by showers. In the spring, a warm rain falling upon the land may pass down into the lower layers of soil and thus warm up the soil to a great depth.

Under ordinary field conditions, it is difficult to determine just how effective decaying organic matter is in increasing the temperature of the soil. However, an ordinary hotbed is a good illustration of the heating power of decaying organic matter. Large amounts of manure are allowed to decay in a hotbed, and during the process of decomposition, enough heat is given off to aid materially in increasing the temperature of the seedbed. Undoubtedly the most important source of soil heat is the sun's rays. Field soils get very little heat from decaying organic matter.

The slope of the land may have a marked influence upon the temperature of the soil. The soil on a south slope is generally several degrees warmer than the same type of soil on the level or on a north slope. This difference in temperature makes a south slope desirable for truck crops, and gardeners have taken advantage of this fact in many parts of the country. The texture and structure of the soil probably do not have any direct effect upon the temperature, but the amount of heat in a soil is governed largely by its water content. Since texture and structure chiefly control the amount of water in a soil, these two factors may indirectly influence soil temperatures. A large amount of heat is required to evaporate water. For this reason a soil such as clay, which usually contains a large quantity of water, is generally cold. Sandy-loam soils usually warm up early in the spring because this type of soil is coarse in texture, and drainage conditions are quite satisfactory.

There are several farm practices which may be followed to regulate the temperature of the soil. For example, thorough drainage is the most effective means of getting rid of surplus soil water, and thus increasing the heat of the soil. Soil that has been properly drained can be seeded earlier in the spring because it is warmer than wet soil.

# THE PHYSICS OF THE CARE OF LIVESTOCK

*By* PROFESSOR JOHN M. EVVARD *of the Iowa State College (see Volume III, Chapter 34), whose experience along animal husbandry lines at the Illinois, Missouri and Iowa Agricultural Colleges, following a boyhood of practical farm work and a general university course in agriculture, has given him a particularly keen knowledge of science as related to practice. It is sometimes difficult to work out the connection between abstract principles and concrete objects and operations. Professor Evvard has tied these two subjects together as he understands each of them.*—EDITOR.

THE laws of physics have deep significance in practical animal husbandry. To be able to turn them to economical account is of much value and importance to the livestock grower.

## The Physics of Feeding

In the very make-up of the digestive apparatus of animals, there is a considerable variation so that we find the pig, for instance, adapted to highly concentrated feeds such as corn, barley, rye, wheat middlings, and milk, but very poorly adapted to the eating of rough feeds, such as timothy hay, corn fodder, or wheat straw. On the other hand, ruminants—animals with four stomachs, such as the ox or the sheep—are particularly well fitted for the handling of roughages.

Now how shall the feed be prepared for animals? Is the feed as nature made it good enough, or can we advantageously grind the corn, for instance, that goes into the stomachs of different animals?

It has been found that too much pampering and preparation through the physical reduction of the grains to a powdered or at least a finely divided form, is entirely unwarranted and physically wrong under certain conditions. A practical livestock man keeps these things in mind, and prepares his feeds according to the class and needs of the stock.

Generally speaking, rough fibrous feeds such as oats can be ground to advantage for dairy cows, or sheep, or horses, or pigs, particularly when they are being pushed heavily or crowded excessively.

The soaking of feeds, really a mechanical method of softening them, is in order, particularly if the feeds are rough and fibrous, and the soaking can be done economically.

Soaking, however, is more in order with pigs than with any other class of animals.

**Cooking of feeds** has not been found economical excepting perhaps the cooking of cull beans, potatoes and alfalfa for pigs, in which cases the cooking brings about physical changes. In the case of potatoes, it reduces the starch granules to a more soluble form; with beans it increases the palatability and breaks down the fibrous hull; and with alfalfa it increases the tenderness and palatability, and renders the fibre more vulnerable to the digestive juices. With show animals, cooking is often of advantage.

**How to water livestock** is quite an interesting problem. With dairy cattle it is good practice to keep water accessible at all times; and in winter it is a good proposition to use a tank heater and thus keep ice out of the troughs. Sheep do splendidly if the water is kept open and before them all the time. They even thrive nicely if water is in a semi-frozen condition, but it is preferable that it does not contain ice.

There has been a great deal of discussion as to the time to water horses,—before meals, during meals, or after meals, but about the best conclusion one can come to is simply to instruct the novice to water the horses whenever they will drink, in truth to keep water before them always, if possible. Of course, a real "hot" horse should not be watered excessively on cold water because it is liable to chill him and cause serious digestive disturbances because of the nervous shock.

As for hogs, in summer, open running water is in order, and if it is quite cool, all the better; in winter, it is a good plan to keep the ice out of the water.

**How often to feed?** Shall we feed once a day, or twice, or three times? With animals that have simple stomachs, particularly young animals, frequent feeding is in order. This is true of young lambs as well as young pigs. A little calf should be fed very often if best results are to be secured.

FIG. 317. The more comfortable and contented livestock are kept, the more readily do they respond to intelligent treatment. How to keep them so is largely a problem in applied physics.

Shall we feed animals all they will eat, or shall we limit the ration? This depends upon so many factors that it is difficult to decide, but generally speaking, if one wishes to finish his animals quickly and secure a high dressing percentage and that with a relatively less amount of dry matter, full-feeding usually wins as compared to limited feeding of grain. But on the other hand, if grain is very high priced, and roughage comparatively cheap, limited feeding, particularly when corn silage is used, has the preference.

**Bulk in the ration** is important, particularly with breeding stock and with ruminants. Young calves, for instance, do very poorly if kept on a milk diet; their "roughage" stomachs do not develop properly and oftentimes they become unthrifty. A certain amount of bulk in the ration also tends to keep down digestive disturbances, particularly when the animals are being heavily fed on concentrated feeds. A certain amount of bulk also tends to promote laxativeness which is a blessing as contrasted with constipation.

But for fattening animals it is sometimes inadvisable to get too much bulk in the ration, especially in the case of pigs which can not stand much fibre.

Feeds may be compared to gasoline or coal since they are eaten by animals to keep up their body heat as well as to be converted into storage products. Of all the heat units given in the form of feed to a draft horse, 25 per cent is used just to keep his weight up, 20 per cent is used for locomotion, 5 per cent is used for ascending grades, and 50 per cent is used for pulling or for draft. After all of these needs are met, any surplus of feed is converted into fat much as a surplus of power in the motor of a gasoline engine is converted into stored electricity which is later used to start the motor or to furnish lights. This comparison is somewhat similar to the use of feeds by a horse.

**Energy value of feeds.** We can, therefore, talk of the net energy value of feeds which, physically speaking, means those heat units which the animals are able to use. There is always a certain amount of waste. For instance, a "four-stomached" ruminant eating corn meal is able to utilize only 46 units out of the total 100 consumed, 25 units being excreted in the feces and urine, and 29 being lost as heat, this latter covering the work of conversion. But even at that the animal organism is much more efficient than the steam engine.

There is a difference in animals as to how they can handle the net energy units of feed, swine being much more efficient than ruminants in this respect, as shown by the table at the top of the opposite page.

**The physical wellbeing of the offspring** is of considerable importance, the strength, vigor, and coat of new-born pigs or lambs being strikingly affected by the way the

*Net Energy Values of 100 Pounds of Feed*

| THE FEED | UTILIZED BY SWINE | UTILIZED BY RUMINANTS |
|---|---|---|
| Corn........... | 119 Units | 85 Units |
| Barley.......... | 106 " | 90 " |
| Wheat.......... | 109 " | 92 " |
| Wheat middlings | 104 " | 59 " |
| Bran............ | 75 " | 53 " |
| Potatoes........ | 25 " | 18 " |
| Skimmilk....... | 15 " | 14 " |

mothers are fed during the winter time. A ration of corn and corn silage, for instance, with ewes will not produce as strong lambs as corn, linseed oil meal and silage. A ration of corn alone for brood sows produces weak, small, refined, "little-boned" pigs. Add meat meal, or milk, or alfalfa to this ration, and the pigs come strong and lusty, big-boned, and well-coated. Physically speaking, one has to supply the mothers with the kind of building material that the little pigs or the little lambs or the little colts or the little calves are made out of—else it is physically impossible for the youngsters within to grow and thrive.

## The Physics of Care and Management

Exercise is of immense importance in up-to-date, progressive livestock husbandry, particularly in the case of young growing animals, breeding stock, and those types of horses whose prime function is to exercise in a peculiarly stylish way. The question is largely how much or how little exercise should be given. An old saying comes from the Arabs, the greatest of horsemen of olden times, that "Rest and fat are the greatest enemies of the horse." The horse is an animal of motion, therefore it is essential to keep him performing that particular function. If exercised liberally, he will not fatten unduly.

It is excellent to induce exercise under proper conditions. A bull can be kept in an open paddock, or hitched by means of the ring attached to his nose to a staff on the other end of which is a ring circling a long wire stretched between buildings or posts. A stallion can be kept in an open paddock, worked in the field, or driven on the road. Breeding sheep carrying lambs can be induced to take exercise by scattering the rough feed before them on the pasture so that they will be compelled to reach down and get it, and pick it up here and there. They can also be fed far afield. Brood sows can be hustled about by suitable inventions such as (1) the making of snow paths for them in the winter time leading from their sleeping quarters to the feeding place or out to the field and back; (2) the placing of their feed a half mile or so distant from their sleeping quarters; (3) the location of the watering troughs a few rods from their common abode. They can be allowed to follow cattle to earn their living through physical feed-hunting exercise, or they can be turned into the barnyard where they can work over the litter.

**Shade and sunshine** for livestock are to be doubly, yes, triply emphasized. In the hot summer months, natural or artificial shade is highly in order,—a place where the cattle, and sheep, and horses, and hogs, can go to avoid the hot, direct, penetrating rays of the sun. On the other hand, proper sunshine in season is highly commendable because it keeps the quarters clean, and brings joy and satisfaction into the lives of our domestic animals. Sunshine is a great death dealer to filth and disease-producing organisms.

**Fresh air** is to be commended, but it should be neither too cold nor too warm. Experience will teach us as to what is best, but in any case ventilation is fine and should be insisted upon. Close quarters are to be avoided, and livestock should not be overcrowded else they will not do well.

**Handy feeding places** that are efficient need attention. With a good feeding floor, one can always count on having a nice dry place upon which to feed his swine; this is important. Nice handy bunks which are neither too high nor too low, too wide nor too deep for the animals in question, are essential. The particular bunk should feed to best advantage the particular animal for which it is intended. The more comfortable the equipment makes the livestock, and the more easily you make the livestock do the things you wish them to do, the more easily and readily they will respond to your intelligent treatment.

**The care of the coat** is of interest and importance. Currying or grooming is of considerable value because it promotes thrift and vigor, straightens out the hair, removes the dust and dirt, and stimulates the surface skin and underlying tissues to healthy activity. Blanketing of horses and cattle is in order under certain conditions. Horses that are driven for miles on a cold day, should be blanketed at the end of the journey, especially if they are perspiring and hot, even though they are put in a barn. Steers that are being fitted for show, shed their coats more uniformly if the physical stimulation of a warm cover is continuously present.

Clipping the coat in the spring time is particularly advantageous in that it promotes a uniform shedding, and avoids the inconvenience of the driver becoming covered with shedded hairs. It also makes currying and cleaning easier, and if not done too soon in the spring, it is a great comfort to the animals.

Color considerations are frequently worth taking into account from a physical standpoint. White pigs, for instance, tend to blis-

ter more easily than black pigs. Hampshire swine which have white belts on black bodies tend to blister more easily where the skin and hair are white. For this reason, white hogs in the far South must be handled carefully especially during dewy, hot weather. Red is a protective color, as is black. It is noticeable that hogs tend to blister over the ears more than other places, because there is no hair on the ears to protect them. Their snouts will also be blistered at times for the same reason. When hogs are marked by the clipping system, care should be taken not to remove too much hair.

A concrete hog wallow for swine is exceptionally advantageous, particularly in the hot summer months. The hog has difficulty in keeping cool in the summer time, particularly when he is well fed, therefore, if he can get into the water, wetting himself thoroughly all over, evaporation will take the heat units from his body and thus keep him comfortably cool. It is well to arrange this wallow so that it will be easily accessible at all times, especially for fattening hogs.

It is often necessary to place mechanical constraint upon animals. The boar may have to have his tusks removed regularly by means of a bolt clipper or other scheme. This will prevent him doing serious physical damage if he happens to be of the wrong disposition. Yokes can be put upon cattle to prevent them from going through the fences. Rams can be blanketed so as to prevent them breeding the ewes out of season. Feeding racks can so be built that the weed and hay seed will not fall on to the necks of the sheep, and thus contaminate their wool with seeds and rubbish, hard to remove. The feet of horses, cattle, pigs and sheep should be trimmed in order to keep the hoofs healthy and upright so that the animal will walk nicely and not bend outwardly or inwardly in abnormal fashion. Such little mechanical maneuvers as these are of immense benefit.

**Labor-saving devices** are of immense importance in caring for animals, especially when the animals can act as the device themselves. In the "hogging-down" of corn, the animals, by doing physical work, are enabled to add much to the revenue from the farm.

**The manurial waste from livestock** is sometimes deplorable, and we should take advantage of all the physical and mechanical means possible to conserve the manurial value of our feeds. Practically all of our high-grade protein concentrates have a fertilizing value equal to at least half of their gross market value for feeding purposes. Meat meal tankage used for pig feeding has a fertilizer value approximately two-thirds of its feeding value. The man who feeds this material can recover as much as 90 per cent of the total fertilizing ingredients because the animal organism does not utilize more than 10 per cent, passing the balance into the manure. As our land grows older and as our soil becomes poorer, the fertility values of feeds must be remembered.

**Warmth and Shelter.**—The wool on the sheep is of particular advantage in keeping the animals warm. This animal stands out in marked contrast to the pig which must be sheltered in a warm place to do well; outside feeding is out of the question, particularly in cold climates such as the northern corn belt. The dairy cow also needs warmth and care, yet on nice, warm, sunshiny days she should be turned out for a little exercise. The fattening beef steer is quite comparable to the fattening lamb in that he does better in the open shed. It is folly to attempt to feed steers under Corn Belt conditions as they do in southeastern sections. To tie the individuals in warm stalls is a waste of labor, of feed, and of the final product, not only as regards quantity but also as regards quality. There is such a thing as being too kind to domestic animals.

**Ventilation.** There should be an abundance of air in our stables and barns, yet not too much; drafts should by all means be avoided. In winter, ventilation is of course, more difficult to secure than in summer, but it should be kept in mind and striven for nevertheless.

**Bedding the animals** well is quite essential in that it makes them warmer and more comfortable, protects them from the dampness, and serves to absorb the manurial residue which is otherwise drained away or makes a wet, soggy place in the barn. Excellent bedding is provided in shredded corn stover, the pith of which absorbs a large amount of moisture. Wheat straw is also good, and lasts much longer than oat straw because it is tougher and more fibrous. The point, though, is to get a good bed that is warm and dry.

One thing that is to be emphasized in the management of all classes of livestock, is protection from rain, snow and sleet. The dairy cow particularly should be well protected, and sheep should be kept out of cold driving rains which soak up their fleeces and increase their weight. All young stock should be very well protected, particularly growing pigs, and more especially very young ones. New-born lambs also need to come in warm quarters. The little colt and the little calf require and deserve special care at this time; in truth, it is the most critical time, in so far as housing is concerned, of any time in the life of the animal.

The question of where to feed animals often comes uppermost. Beef cattle can be fed (particularly their grain) on the southern slopes outside their sheds. It is well, however, to feed the roughage inside if possible. If the animals are in thin condition, inside feeding is more in order than if they are in the fattening stage. Dairy cattle should by all means be fed both grain and hay inside, particularly in the winter. In the summer time, they could be fed out on pasture if that is economically done, but preferably then in the shade. Horses in the summer time can

be fed either in the barn or out in the open, but it is common custom to feed growing colts and breeding stock out in the pasture under the shade of a tree. Sheep in the summer can be fed in the open but in the winter time it is perhaps a good plan to feed them under shelter. Where there is little rainfall, the precipitation coming mostly in the form of snow, outside feeding gives exceptionally good results. With swine the story is entirely different; even in the summer time, they should be fed in the shade if possible, and in the winter time under cover where it is warm and cozy. Pigs are like human beings and can not stand the excessive cold. From the standpoint of housing, therefore, the general management of livestock resolves itself down into a series of individual problems, particular attention being paid to the kind of animals and the purpose for which they are kept.

# THE SCIENCE OF THE WEATHER

*By* PROFESSOR J. WARREN SMITH, *Chief of the Division of Agricultural Meteorology of the U. S. Weather Bureau. Raised on a New Hampshire farm, he graduated from the Agricultural College of that state in 1888, and took special work at Harvard College for 2 years, attending also the first graduate summer school at the Ohio State University. From 1890 to 1915 he was Section Director of the U. S. Weather Bureau in charge of climate and crop work being located in New England until 1896, in Montana from 1897 to 1898, and in Ohio from 1899 to 1915, except in 1910 when he was District Editor in Missouri. From 1898 to 1909 he was Special Lecturer in the College of Agriculture of the Ohio State University, becoming Professor of Meteorology there in 1911. In his present position, he has supervision of all special activities of the Weather Bureau in connection with agriculture, and edits the National Weather and Crop Bulletin. He is the author of a number of very practical bulletins on weather and crops.*—EDITOR.

LITTLE wonder that some races have been sun worshipers, because sunshine meant comfort and life to them, and its absence, suffering and even death. We now know that all life and action on the earth is sustained by the sun, and without the solar radiations, our globe would be a dark, cold mass, frozen solid. And yet the earth intercepts only one two-billionth part of the total energy given off by the sun, and we are so far away from it that if we had an arm long enough to reach the sun it would be 147 years before we would realize that the finger that touched it was being burned.

**Warming and cooling.** Heat is transferred by radiation, conduction, and convection. If a man stands near a large fire out of doors, the side of his body that is toward the fire will be warmed by it, even though the temperature of the air all around may be far below freezing. This transfer of heat from one object to another through a medium that may itself be little affected, is called *radiation*. Radiation from the sun warms the surface of the earth, but only very slightly warms the clean dry air through which it passes. *Conduction* is the transfer of heat by contact. If our hand is placed on a heated object, it is warmed by conduction to the hand; if upon a cold piece of metal, the hand is cooled by conduction of its heat to the metal. The surface of the earth and objects upon it are warmed by radiation from the sun, and the surrounding air is warmed by conduction. At night time, the surface of the ground becomes cooled by radiation of its heat through the air into space, and the air in contact with the ground is cooled by conduction.

The movement of heated air is called *convection*, and it is due to the fact that warmed air expands and becomes lighter and is pushed upward by the colder and denser air that surrounds it. If bits of light paper are let loose above a hot stove, they will be carried upward toward the ceiling; leaves are often seen rising to a considerable height above a brush fire. Air, therefore, that is warmed by conduction, is carried upward by convection and in turn warms other air by conduction and intermixture.

As the earth that is in direct sunshine is warmed faster than that in the shade, and the slopes which are perpendicular to the sun's rays faster than those which the rays strike more obliquely, and some objects gain heat faster in sunshine and lose it faster in the shadow than others, and as the air in contact with the earth rapidly acquires the temperature of these objects by conduction, and as adjacent masses of air of different temperature and density must flow to new positions of equilibrium under gravity, it follows that there is a constant shifting of the atmosphere about us due to the frequent variation in its density.

**WHAT MAKES THE WIND BLOW.** Variations in the density or pressure of the atmosphere, due to differences in temperature, cause movements in the atmosphere which

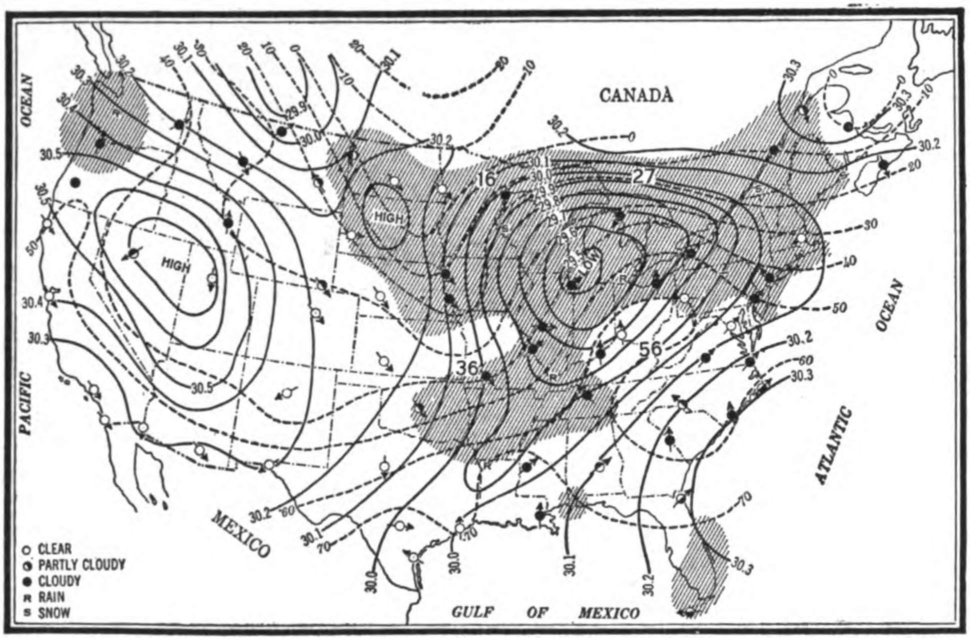



**Fig. 318.** These charts, adopted from U. S. Weather Bureau maps, show the progress in 12 hours of a typical winter storm, and the changes accompanying it. Black lines connect places having equal barometric pressure, dotted lines, those having equal temperature; circles show weather conditions, and arrows the wind direction. HIGH marks the center of a high-pressure (anti-cyclone) area, and LOW, the center of a low-pressure (cyclone) area. The shading shows the precipitation area; and the large figures show the average temperatures in the four quarters of the cyclone.

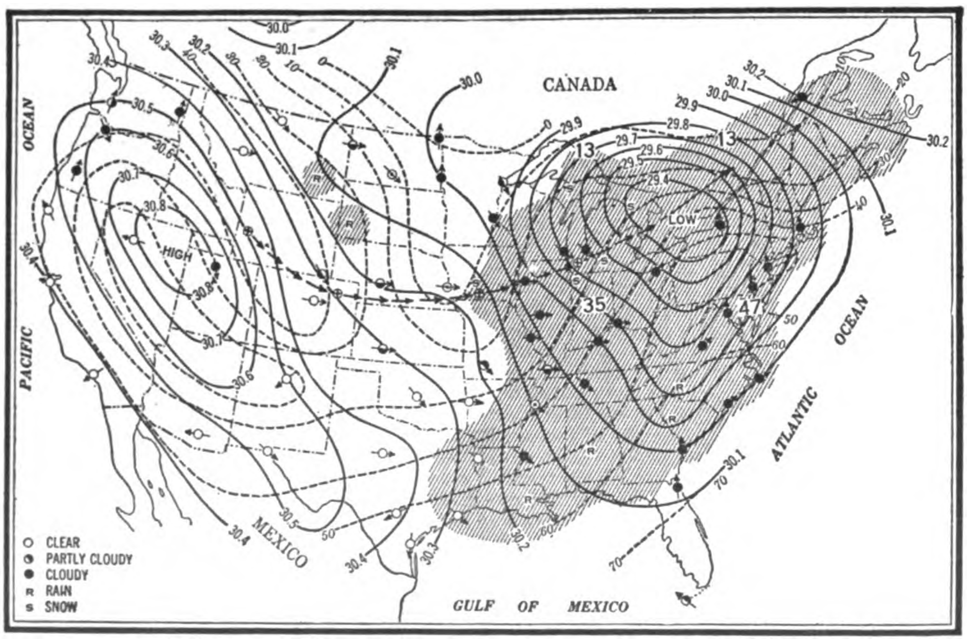



**Fig. 319.** Note that the storm center has moved from near Chicago to Buffalo; and that under the influence of the north winds following it, the temperature dropped suddenly and as much as 20 degrees in some places. The line of heavy black arrows shows the course of the storm center. Compare with Fig. 295.

are called winds. Although local variations in temperature cause an almost constant movement of the air around us, the more extended air movements or winds (both those which prevail at the surface of the earth and which carry along the clouds in the higher atmosphere) have more than a local origin. They are in fact related in a complex and indirect way to the great contrasts of temperature ranging all the way from the equator to the poles. Not only this, but the high south wind of yesterday, the strong northwest wind of today, and the cold raw wind of last week, were none of them due to local differences in temperature but were the cause themselves of the temperatures which we experienced.

The action of the sun's rays in causing higher temperatures in the equatorial regions than about the poles, higher temperatures over land in daytime and summertime than over water, higher over deserts than wooded regions, etc., cause permanent, seasonal, or accidental variations in atmospheric pressure in different parts of the earth, and in equalizing these differences in pressure, there are correspondingly permanent, seasonal, or accidental movements of large masses of air, which we designate as "winds."

**Cyclones and anti-cyclones.** The solar energy, acting in some manner not clearly understood, sets up atmospheric waves or whirls which are thus called. *Cyclones* are large areas of low barometric pressure influencing an area of from 500 to 3,000 miles in diameter, which (in the latitude of most of the United States) move eastward at an average velocity of about 600 miles in 24 hours. These must be distinguished from *tornadoes*, which are narrow violent storms causing great damage along comparatively short paths. *Anti-cyclones* are large areas of high pressure which move eastward with slightly less velocity than cyclones.

**Daily weather maps.** The cyclonic areas are shown by the words "low" and the anti-cyclones by the words "high" on the daily weather maps published by the United States Weather Bureau in different parts of the country, and are illustrated by Figures 318 and 319. Data showing pressure, temperature, weather, clouds, wind, etc., are telegraphed twice daily from hundreds of places in the United States and in other parts of the northern hemisphere to all the large cities of the country. These data are immediately charted on outline maps so that each 12 hours a weather picture is made covering thousands of miles in extent.

**Laws of storms.** The charting of the daily weather conditions in the manner referred to above has determined that there are certain well-defined laws in connection with the movements of the atmosphere:

1. *High and low pressure areas* move across the country in the latitude of most of the United States in an easterly direction. Figure 295 shows the average path and rate of movement.

2. *Surface winds* are controlled by differences in pressure. The wind blows toward areas of low pressure and away from areas of high pressure. See Figures 318 and 319.

3. The *temperature* at any place is influenced by the wind direction, and depends upon the temperature in the region from which the winds come. The maps show that it is warm to the east of the low pressure areas in the north temperate zone because the winds blow from the south, and colder to the west of them because the winds blow from the north.

4. Low pressure areas are usually accompanied by *cloudy weather* with rain or snow, while high pressure areas are more apt to be attended by clear skies and fair weather.

5. The lower the pressure at the center of the low, and the greater the variation between this pressure and that which surrounds it, the higher the wind velocity and the more likelihood of severe local storms such as *thunderstorms, hailstorms,* and *tornadoes* if it is in the summer time, since these are all local disturbances which occur in connection with the larger cyclonic whirls.

## Weather Forecasts

**Local weather signs.** An observing person whose work takes him out of doors a good deal can make fairly accurate weather predictions from local weather signs for a few hours in advance. The most important matters to consider in this connection relate to the wind and the clouds.

**WIND.** As noted from the laws mentioned above, surface winds blow toward areas of low pressure. In the latitude of the United States, areas of low pressure move from the west toward the east and are usually accompanied by cloudy and stormy weather. Hence as the disturbance moves toward us from the west, the wind where we are sets in from the east, and is soon followed by rain or snow because the conditions which produce the rain and snow are moving toward us from the west. This is why east winds are proverbially rain winds, although the rain comes from the west and not from the east. After the storm center passes by, west winds prevail and the rain is followed by a spell of fair weather. This agrees with our experience that winds from the west are associated with clearing and fair weather. South winds are mild because they come from a warmer dis-

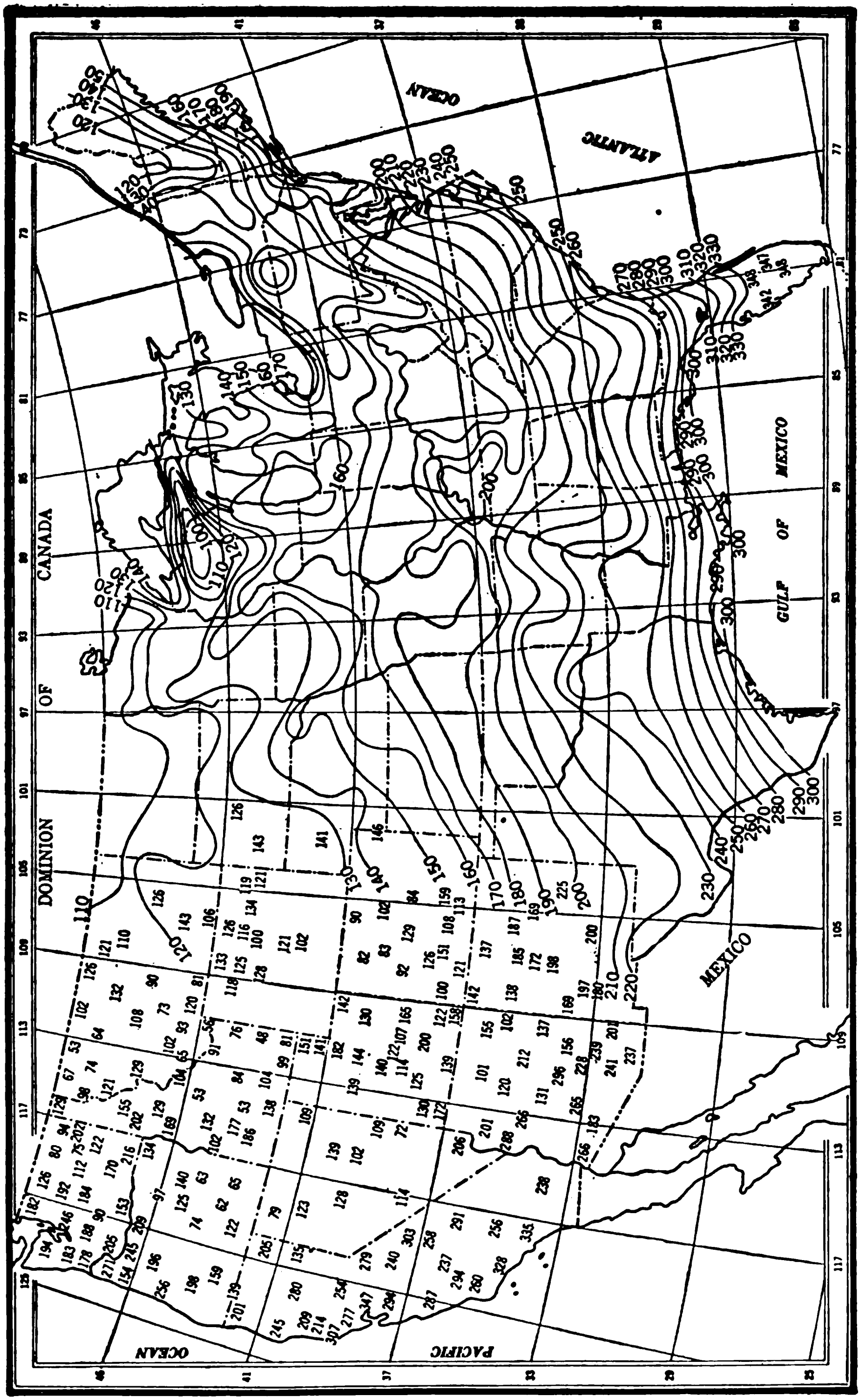



FIG. 320. Average length of the crop-growing season (in days) in different parts of the United States. The lines pass through places having seasons of equal length. West of the 101st meridian, variations in altitude, etc., cause great local variations which make any systematic charting impossible. (U. S. Weather Bureau.)

trict, and north winds are cold because from a region of lower temperature.

CLOUDS. The well-known couplet giving advice to sailors is worth recalling:

If clouds look like they had been scratched by a hen,
Get ready to reef your top-sails then.

The high, thin clouds which sometimes cause circles around the sun and moon (halos) are composed of ice particles which have been condensed in winds carried to a high altitude in a storm area that is approaching from the west. As these clouds become thicker and lower, the storm is getting nearer and nearer. If the high clouds are moving rapidly eastward and the sky below is partly covered with denser clouds moving westerly, then the storm is approaching rapidly, and heavy rain and strong winds may be expected. When the lower clouds begin to break up and enough clear sky can be seen "to patch a Dutchman's breeches," fair weather may be expected very soon. A brilliant sunset indicates that there is a large amount of moisture in the atmosphere that will probably be precipitated as dew during the night with fair weather the following day. A brilliant sunrise, on the other hand, indicates that the moisture which causes the bright colors will probably be condensed and precipitated as rain during the day. Hence:

Evening red and morning gray,
Will set the traveler on his way;
But evening gray and morning red
Will bring down rain upon his head.

HUMIDITY. There is usually an increase in the humidity of the atmosphere before a rain, because our rains are usually preceded by warm, southerly winds that are taking up moisture as they flow northerly. Certain phenomena are brought about by increasing moisture and other factors, and hence are good rain indicators. Some of them are: Sweating walls, sidewalks, metal plates, and dishes; tightening of ropes, shortening of guitar strings, tightening up of curls, softening of moss, tobacco, and corn fodder; increase in the perfume of flowers, as well as of the offensive odors from drains and ditches.

## Long-Range Weather Forecasts

All weather forecasts for more than a week or ten days in advance are usually based on seasonal or average conditions, and should seldom be given serious consideration.

OLD-TIME FALLACIES. The color of the goosebone, the thickness of corn husks and of the fur of animals, the store of nuts laid up by the squirrels, etc., all show the effect of *past* weather and are in no way indications of future conditions. Forecasts for days, months, or seasons based on the weather of special days, as well as those based upon the conjunction of the planets, the appearance of the moon, etc., cannot stand the test of verification. Sunspots have no direct effect upon the weather; and there is no established relation between the moon and the weather. While there is a saying in the South that "chickens should be picked in the dark of the moon," no one considers this an indication that any consideration should be given to the position of the moon in any farm work.

FORECASTS BY THE WEATHER BUREAU. The forecasts issued by the Weather Bureau are based on twice daily telegraphic reports from several hundred places in the United States and other parts of the northern hemisphere. They are made for definite locations and periods, and are correct 90 per cent of the time.

The forecasts sent out at about 9 A. M. (75th meridian time) are based on the weather map showing the prevailing conditions at 8 A. M. throughout the country. These cover the probable conditions for the next 36 hours and are widely distributed by mail, telephone, and telegraph at Government expense. The forecasts issued at about 9 P. M. are based on the 8 P. M. weather maps, and cover the expected weather for the following 48 hours. On Saturdays a general forecast is issued for the following week.

Hundreds of thousands of people are getting the daily forecasts and special warnings of the Bureau who have found that the man who does not take advantage of this important information puts a big handicap on his operations. Fair weather forecasts for harvesting alfalfa; cold, stormy weather in the sheep lambing and shearing season in the far Northwest; flood and high-water warnings along the rivers; fire weather warnings in the great forests; warnings of high winds, gales, and hurricanes along the coasts; special temperature forecasts for shippers of perishable products; heavy snow and cold-wave warnings for transportation and other interests; frost warnings for tobacco fields, cranberry bogs, sugarcane plantations, citrus groves, and for thousands of fruit orchards where action is being taken to protect the tender blossoms by orchard heating, are only a few of the special forecasts and warnings widely disseminated by the Weather Bureau.

## Rain

The temperature determines the amount of invisible moisture that the atmosphere can maintain, and at a temperature of 40 degrees F. it cannot contain more than half as much water vapor as it can at 60 degrees. Almost one-half of the total water vapor in the whole atmosphere is within one mile of the earth's surface.

A room 20 x 20 feet and 10 feet high contains 4,000 cubic feet of air. If this air is completely saturated at a temperature of 80

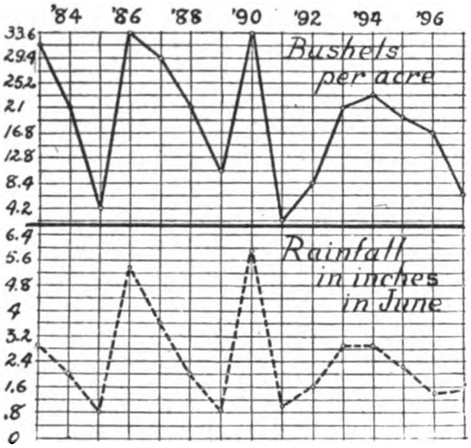



FIG. 321. The relation between the rainfall in June and the yield of oats as observed at a Russian experiment station over a period of years. Oftentimes the distribution of the moisture supply is fully as important as its total amount. (International Institute of Agriculture.)

degrees, there would be 3 quarts of water in it. If the temperature should be lowered to 60 degrees, one half of the moisture would be condensed and deposited on objects in the room, and the water vapor or invisible moisture would amount to only 3 pints. If the temperature should be reduced to zero, the amount of water vapor that the air could contain would represent less than 0.3 of a pint of water.

Rain is caused, then, whenever a large mass of air is cooled below its dew point or temperature of complete saturation. Clouds are formed just as soon as the dew point is passed, and if the cooling is continued, large drops will be formed and will fall to the earth as rain.

When a mass of air is carried to higher altitudes by any cause, it expands and, until it reaches the temperature of complete saturation, it cools at the rate of one degree for every 180 feet of elevation. If a current of air with a temperature of 80 degrees and three-fourths saturated with moisture, is forced to 10 times 180 feet, or a little more than one third of a mile, some of the moisture will be condensed into clouds and rain.

Ascending air, then, is cooling, its capacity for moisture is decreasing, and clouds and rain may result; this is the principal cause of rain. Wherever large masses of warm moisture-laden air are carried up over a mountain side or forced up in a cyclonic area or local thunderstorm whirl, heavy rains may be expected. These areas of heavy rainfall usually move easterly with the general storm movements, but whenever for any reason the center of the rapidly ascending currents of air remains nearly stationary, excessive local rainfalls occur and floods are caused.

**Meaning of rain.** A rainfall at the rate of one inch an hour is considered excessive; one inch of rain is 27,154 gallons or 113 tons per acre. Two and one half inches of rain in 24 hours is an excessive rainfall; this equals 67,885 gallons of water on each acre. A rainfall of 1 to 3 inches during a heavy summer thundershower is not unusual. A moderate rainfall would be one of one half to three fourths of an inch. A fall of less than one fourth inch is of little or no benefit to any well-rooted crop, especially during a dry spell.

**Thunderstorms** occur only where there is a rapidly rising current of moisture-laden air, and wherever convection currents are frequent, thunderstorms are also frequent. They are most apt to occur in the hottest time of the year and in the warmest part of the day. In the United States, the average number of days with thunderstorms each year is 60 in the Gulf States, 50 in Missouri and eastern Kansas, over 30 in most of the Great Central Valley districts, and less than 20 in New England, upper Michigan, and the Rocky Mountain States; they are very rare on the Pacific Coast.

After saturation has been reached, condensation goes on rapidly in an ascending current of moist air, and during this condensation electricity accumulates with marked rapidity. As clouds form in this ascending current, different clouds or different parts of the same cloud will be charged with different kinds of electricity.

The atmosphere between the earth and clouds is a poor conductor, especially in cloudy and rainy weather. The strong electric charge in the lower part of the thunderstorm cloud, as it moves along above the surface of the earth, causes the opposite kind of electricity to accumulate in the earth's surface beneath it. As a result great changes in potential are caused which may result in a violent discharge of electricity between the cloud and the earth which is known as lightning. Hence lightning may be defined as an "electric spark on a tremendous scale." Discharges of electricity take place more frequently between different parts of the same cloud than between the cloud and the earth.

The object of a lightning rod is essentially to provide a safe path for the lightning when

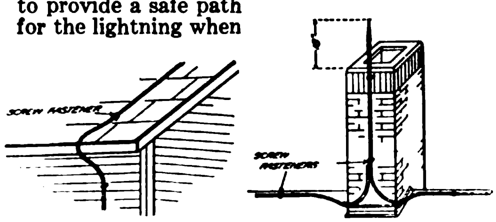


FIG. 322. Correct methods of arranging a lightning rod on, and attaching it to, a building. (Farmers' Bulletin 842.)

the electric potential between the cloud and the earth reaches the breaking point, and a violent discharge takes place. That a properly installed lightning rod will furnish a safe path for this discharge of electricity, is shown from a large number of statistics on lightning damage. With an equal number of rodded and unrodded buildings in a community, lightning will damage 9 unrodded buildings, on an average, for every 1 that is rodded. In some districts this ratio is as high as 99 to 1.

It is neither difficult nor expensive to properly rod a farm building. The important things to remember are that points or lightning rod connections must extend above all roof projections, and a continuous downward circuit be established from these points to permanently moist soil below. Farmers' Bulletin 842 gives excellent information in regard to putting up lightning rods.

## Climate

The Weather Bureau maintains a large number of meteorological stations in each state, and the average rainfall and temperature values have been determined for each month and year, as well as the dates of frosts, length of the growing season, etc. The Office of Farm Management of the Department of Agriculture has prepared charts showing the necessary growing days for various crops. If one wishes to know the relation between the climate and weather on the one hand and the development of crops and of farm activities on the other in any part of the country, letters of inquiry should be sent to these offices.

## Some Things Worth Knowing

That frost does most damage on low ground and that gardens and tender fruit crops should be set on the hillsides so as to get good air drainage.

That it is practicable to protect fruit and garden crops from frost damage by building small fires of oil, coal, or wood at the rate of from 50 to 100 per acre, and that by means of such fires, it is possible to keep the temperature in the heated area from 5 to 15 degrees higher than that outside. Plans must be laid carefully, however, so as to have plenty of heaters, fuel, and labor.

That wire fences should be grounded every fourth or fifth post to prevent loss of stock by lightning running along the wires.

That the climate is not appreciably changing, notwithstanding the memory of the oldest inhabitant to the contrary.

That the words "fair," "change," "rain," "stormy" on the dial of the aneroid barometer have little or no significance, and not only cannot be depended upon but may be very misleading.

That it is possible by the science known as Agricultural Meteorology to determine the weather factor having the greatest influence in varying the yield of the various crops, as well as the most critical period of development.

That in a record in Ohio covering 60 years with each variation in the rainfall during July of one-half inch, near the critical rainfall point, there was an average variation of the yield of corn amounting to 15,000,000 bushels.

That when the rainfall for July over the 8 great corn states has averaged more than 4.4 inches, the yield of corn has averaged greater by 500,000,000 bushels than when the rainfall has been less than 3.4 inches.

That "rain making" is a fake. That neither can tornadoes be broken up by firing cannon nor hailstorms dissipated by shooting hail guns.

That among the business risks of farming, those that grow out of unfavorable weather conditions are of greatest importance, and that no type of agriculture can be successfully es-

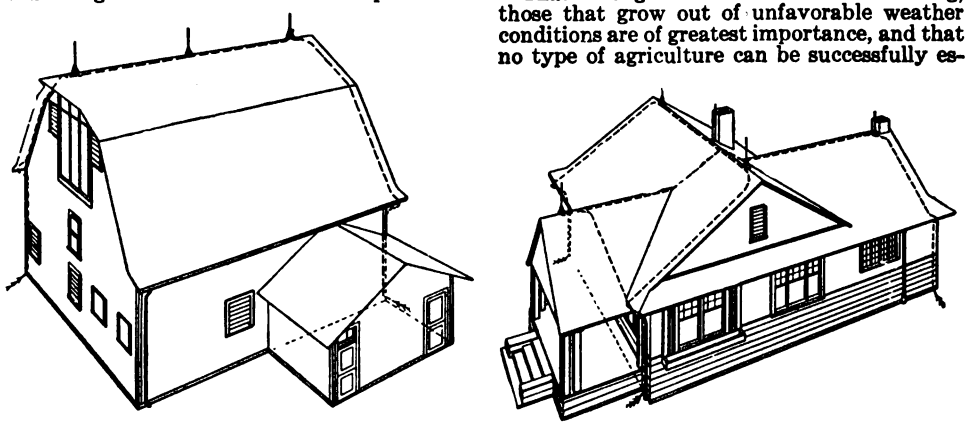


Fig. 323. Effective wiring systems for the protection of a barn and a farmhouse. The highest point of the rod should extend at least eighteen inches above the highest point of the building; the course of the wire should be as direct and free from sharp turns as possible; and the ends should be grounded deep, preferably in permanently moist soil. (Farmers' Bulletin 842.)

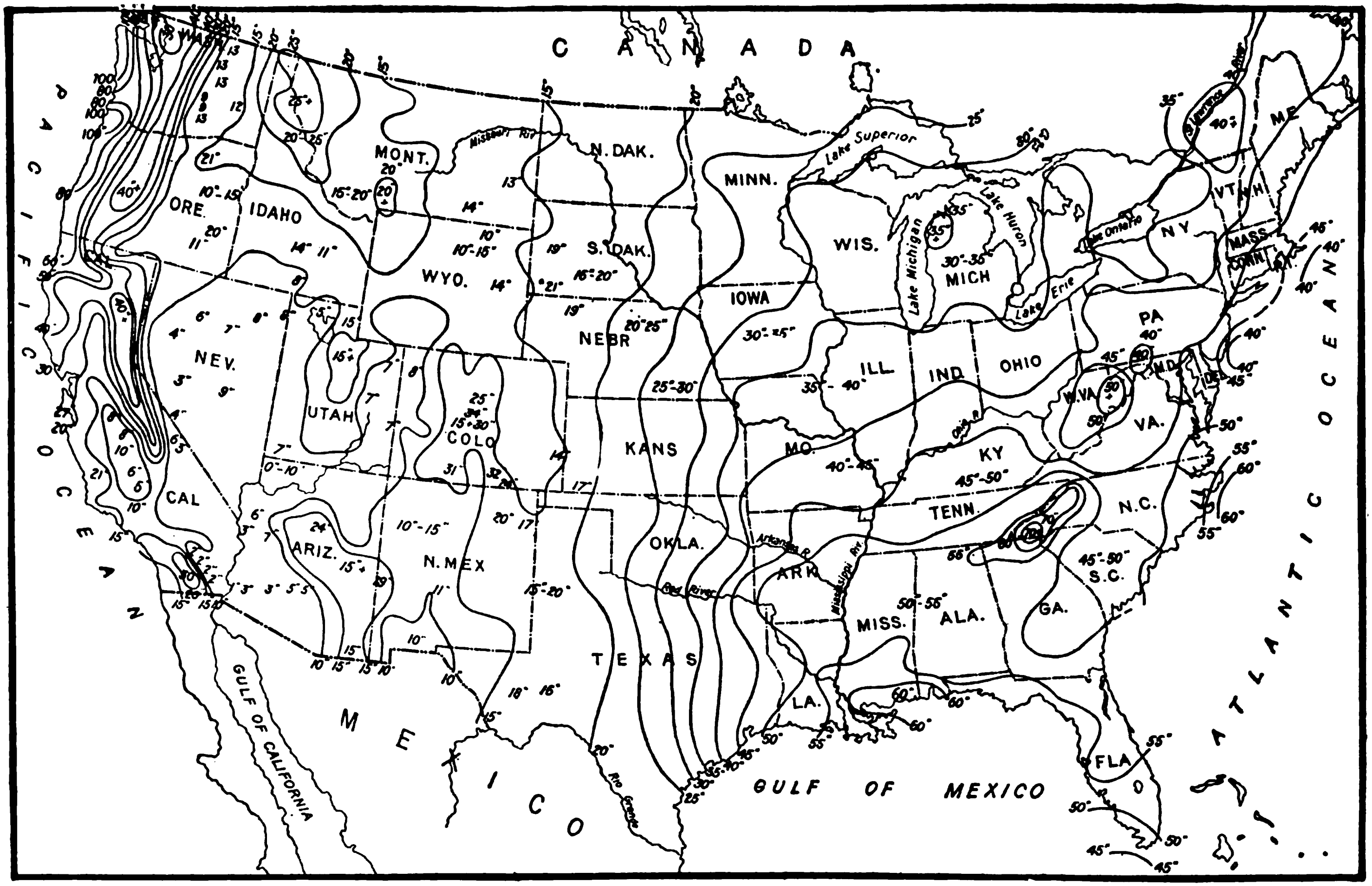



FIG. 324. Average annual rainfall in the United States. The line connecting places receiving 20 inches corresponds closely to the 100th meridian (see Fig. 320), which may, therefore, be said to mark the division between the humid and arid sections of the country. Note the heavy precipitation along the North Pacific Coast caused by the action of the mountain ranges on the warm moisture-laden winds from off the ocean. (U. S. Weather Bureau.)

tablished in a region where the risk of loss by drought, frost, or other unfavorable condition is not more than balanced by the profits at other times.

## The Atmosphere

We travel upon the land and a large proportion of our food is derived from it; we sail about upon the surface of the water and transport important articles of commerce and of food from one continent to another.

We live, however, at the *bottom* of the atmosphere and move about in this gaseous ocean with often little thought of its importance to us or appreciation of the fact that, without the atmosphere, all life would cease to exist on the earth in a very few hours.

Clean, dry air appeals so slightly to any of our senses that we forget its presence until it affects us either favorably or unfavorably in a well-defined manner. Not only is the atmosphere essential to our very life, but the gases that make it up are mixed in the right proportion to be of greatest service to us.

**COMPOSITION OF THE ATMOSPHERE.** Slightly over three fourths (78%) of the atmosphere is composed of nitrogen, while not quite one fourth (21%) is composed of oxygen; approximately one per cent is made up of various gases some of which are very rare. Mixed with the atmospheric gases there are a vast number of dust particles and bacteria, also water in the form of vapor amounting on an average to from one to five per cent of the total weight of a given volume of air. All the main constituents of the atmosphere are essential to our wellbeing.

**Nitrogen** is a comparatively rare element in the earth, but it furnishes one of the most important elements in plant food, and by diluting the oxygen, it diminishes the activity of combustion.

**Oxygen** in chemical combination with hydrogen constitutes eight ninths, by weight, of pure water and combined with other elements it composes nearly 50 per cent of the crust of the earth. It, like a politician, is a good mixer and combines readily with other substances. It is absolutely necessary in the burning of fuel as well as in that form of combustion which takes place in the lungs of air-breathing animals. It is interesting to note that, if the proportion of these two gases should be varied, life would be far different than it now is. With a slightly larger percentage of nitrogen we should be dull and stupid, but with an increase in the proportion of oxygen we should be full of life and energy and sparkling with wit and brilliancy.

**Carbonic acid**, although averaging only about 0.035 per cent by volume of the atmosphere in the open country, is as important in sustaining vegetable life as oxygen is in connection with animal life. As it is 1.5 times as dense as an equal volume of air, it collects in mines, sewers, old wells, and other low and confined places, and replaces the gases which are necessary in life. Fortunately its presence in dangerous quantities can be determined by its failure to support active combustion, hence one should never go down into an old well or similar low confined space without first letting down a lantern or lighted candle. If the light continues to burn freely, the place is safe, but if it is extinguished or burns dimly, one should not venture down without a gas mask or apparatus for breathing prepared oxygen.

**Water vapor** is not important in volume but it is essential for vegetation. It furnishes an important link in the chain of moisture circulation, from the surface of the ocean and other large bodies of water by evaporation into the atmosphere, there forming clouds and rain, watering vegetation as it falls and making up the brooks, streams, and rivers on its way back to the oceans that are so important in our economic operations.

**HEIGHT OF THE ATMOSPHERE.** Water can be brought from a well by a pump from a depth of between 30 and 34 feet because the weight of the air upon the surface of the water equals that of the same area of water 34 feet in height at sea-level. The pressure of the atmosphere amounts to 15 pounds per each square inch of our body surface. As the gases that make up the atmosphere are very elastic, they are greatly compressed near the earth by the weight of the air above so that one half of the whole atmosphere is within 3½ miles of the earth's surface at sea-level. At 10 miles' elevation, the air is not dense enough to transmit sound.

While more and more knowledge is being gained of the lower atmosphere, little is known of its vast upward expanse. The highest that man has ever gone on a mountain side is not quite 4½ miles (23,490 feet) and there the air was so rare that breathing was difficult and extreme exhaustion was experienced with even the slightest movement. The highest point ever reached by man in balloons is less than 7 miles and then unconsciousness resulted except when prepared oxygen was inhaled. Meteorological instruments have been carried by kites to the height of 4.5 miles (23,-800 feet), and by sounding-balloons to the extreme height of 20.2 miles.

A sufficient number of sounding-balloon observations have been made to show that the lowest temperature is some 6 or 7 miles above the surface of the earth where it averages between 60 and 70 degrees F. below zero. From twilight observations and the fact that meteors become luminous by friction with gases at an elevation of 180 to 200 miles, there must be an appreciable amount of some of the gases of the atmosphere at that height above the earth.

# CHAPTER 17

# The Science of Chemistry

*By* H. F. BUTTON, *head of the Department of Farm Crops and Soil Fertility of the New York State School of Agriculture at Farmingdale, Long Island, where he has charge of the 308-acre farm devoted to the teaching of practical agriculture. He was born and raised on a large live-stock and grain farm (which he now owns) near Canastota, New York, and is a graduate of the State College of Agriculture at Cornell University, where, as he says, he "learned the reasons for the facts and practices he already knew from experience." He has combined the teaching of agriculture in school with the giving of practical farm advice, as well as coöperative organization, corn breeding, cow testing, and other rural work. He organized, and was for 6 years Principal of, the Agricultural High School of Manassas, Va., where, incidentally, he aroused, organized and stimulated the farming of the whole neighborhood. As a result of this work the number of farmers growing pure strains of corn increased from one per cent to about ninety; and the practice of cow testing increased to much the same extent. Later he organized the agricultural department of Vincennes University, Indiana, with which he remained for 2 years. He is a specialist in soil fertility and the raising of general farm crops and farm animals. His long experience with practical farmers and their problems, especially qualifies him to treat of technical problems in a practical manner.*—EDITOR.

CHEMISTRY is nothing more nor less than a knowledge of what things are made of, and of how the different parts go together.

More than all the other sciences together, chemistry has made the modern farmer what he is. Chemistry has ended the day of moon signs, sorcery, uncertainty, squalor, small yields, decreasing fertility, and general misery, and has given in their place fertilizers of known composition, accurate knowledge of plant needs, increasing yields, prosperity, and, above all, a feeling that the farmer is master of his job.

In spite of this, most farmers think that they know nothing of chemistry, and mentally "shy out" when a chemical term is used. Many men who have a fair working knowledge of the friction of pulleys, of flow of water in pipes, of cross pollination, and of serum treatment think that they cannot understand the tag on their fertilizer sack or a price quoted on a high-protein cattle feed.

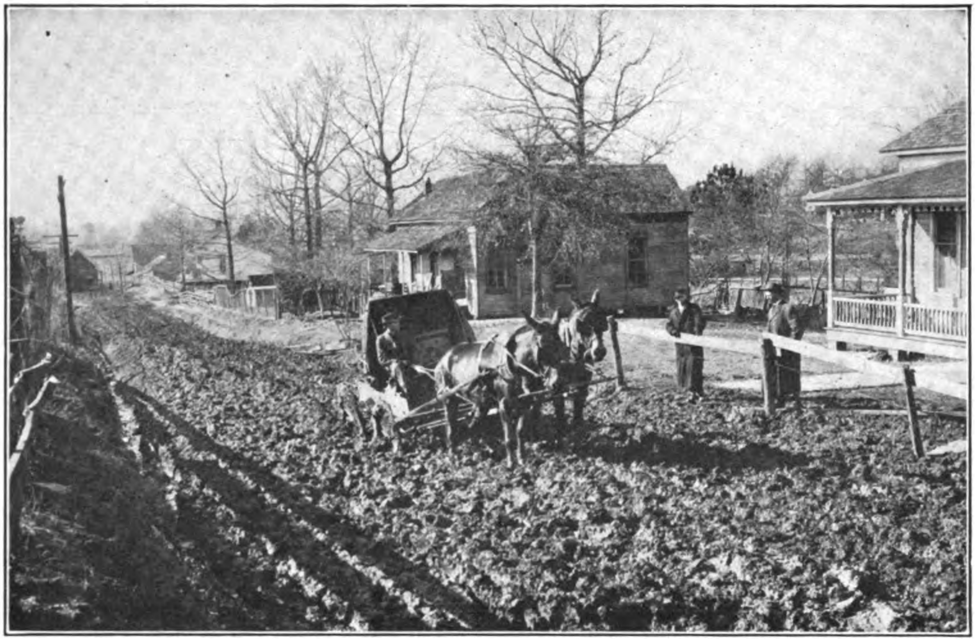
Yet the fact is, that every farmer is a chemist; his success depending largely upon how well he understands the laws which govern the science. When he puts water on lime to make whitewash he practises chemistry; when he mixes land plaster in his hen manure, or refrains from putting in ashes, he is practising the applied art of chemistry. Even more is this the case when he buys fertilizer, makes a spray, boils sulphur with lime, tells his wife that the milk at the creamery tested 3.4, or when he selects cattle feeds according to their composition. His wife is a chemist of no low order when she mixes soda and sour milk, or takes out a stain with lemon, or blacks her stove before setting it away for the summer. Either he or she may do these acts without knowing why, in which case they will be mere followers of those who do know; but, skilled or unskilled, the farmer must be a chemist, whether he wishes to or not.

In fact, chemistry is just as easy to understand as any other of the problems which we have to face. Anyone who can understand a grain binder, or

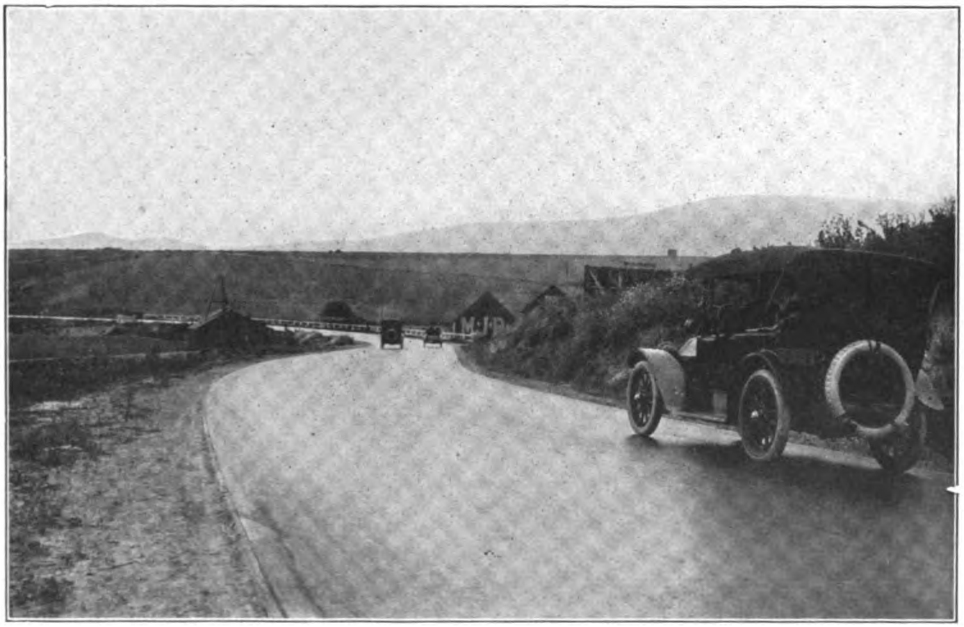
A farmers' club meeting at the home of one of the members. One way to become a better farmer is to study and talk over the other fellow's methods and results

A community field day and picnic is a good chance to get acquainted with your neighbor. As Sam Jordan of Missouri says, "You might like him!"

EVERY TIME FARMERS AND THEIR FAMILIES GET TOGETHER—WHETHER FOR WORK OR PLAY—THEY STRENGTHEN THE BONDS AND INCREASE THE USEFULNESS OF THEIR COMMUNITY



The country road of yesterday that leads, as such roads must ever lead, to ignorance, poverty, and wretchedness



The roadway of to-day is a path of progress, bordered by good farms and good schools, and sharing their benefits with those that use it

THE ROADS OF A COMMUNITY ARE THE LINKS THAT BIND IT TO THE WORLD OUTSIDE, AS WELL AS A MEASURE OF ITS INTELLIGENCE, PROGRESS, AND PROSPERITY

an automobile, or can breed good cows, or manage a general farm can easily understand as much of the elements of chemistry as is essential to make him or her master of the farm or of the household.

It was not long ago that men thought that heat was a substance that escaped when a stick burned; but now we know that it is a result of chemical action or motion. When a chemical change takes place, heat is always given off or taken up. The burning of coal and the decay of manure are familiar examples of the giving off of stored heat; while the growth of the plants stores up a vast amount of heat taken from the sun, to be later used in supplying us or our animals with heat or energy. Thus chemistry treats of both the matter and the energy of our lives.

## The Language of Chemistry

**Elements.** When we studied English grammar, we learned to take a sentence apart; and when we had it all in pieces, we called these fragments the "elements," because the subject and verb were just that, and not even the ingenuity of a grammarian could make them into anything more simple. So, when we take a substance all apart, we call the parts "elements," because they cannot be separated into anything simpler. For instance, we take the wires connecting the terminals of dry batteries and pass the current through water containing a little salt, to make the water conduct the current. The water is changed slowly into two gases; one of these will burn, or, if the two are united, they will explode violently. Both of these gases are elements—oxygen and hydrogen. In another way we can take table salt and break it up into the metal sodium and the poisonous gas chlorine. Anything composed of one kind of matter alone is an *element*, and anything having more than one kind of matter is a *compound*. There are only about eighty elements. Of these not more than twenty-five are of great interest to the farmer, and only a dozen or fifteen take any part in the growth of his plants and animals.

**Symbols.** Since a chemist is as busy as a farmer and has to write them down very often, he has acquired the habit of abbreviating the names of the elements, often making a single letter stand as a symbol of a word.

Thus two of the most common elements are oxygen (the symbol of which is O) and carbon (symbol, C). When one part of hydrogen (H) combines with one of chlorine (Cl) we write it HCl, or, if one part of iron (Fe) combines with one of oxygen (O), we write it FeO. Thus these chemical expressions, or *formulas*, which so often make people afraid of the science, are really an advantage, as they tell just what is in the substances they refer to.

If more than one part of an element combines with a part of another, we show the fact by a small figure following, and below the line, as $H_2O$ for water, or $CO_2$ for carbon dioxide, or $NH_3$ for ammonia, or $CaCO_3$ for limestone, or $H_2SO_4$ for sulphuric acid, which is used in making fertilizer and testing milk.

Common Elements with Their Symbols, Valences, and Weights

| Element | Symbol | Valence | Weight |
|---|---|---|---|
| Aluminum | Al | 3 | 27 |
| Arsenic | As | 3 and 5 | 75 |
| Bromine | Br | 1 | 80 |
| Calcium | Ca | 2 | 40 |
| Carbon | C | 2 and 4 | 12 |
| Chlorine | Cl | 1 | 35 |
| Copper (Latin *cuprum*) | Cu | 1 or 2 | 64 |
| Gold (Latin, *aurum*) | Au | 1 and 3 | 197 |
| Hydrogen | H | 1 | 1 |
| Iodine | I | 1 | 127 |
| Iron (Latin, *ferrum*) | Fe | 2 and 3 | 56 |
| Lead (Latin, *plumbum*) | Pb | 2 and 4 | 207 |
| Magnesium | Mg | 2 | 24 |
| Nitrogen | N | 3 and 5 | 14 |
| Oxygen | O | 2 | 16 |
| Phosphorus | P | 3 and 5 | 31 |
| Potassium (Latin, *kalium*) | K | 1 | 39 |
| Silicon | Si | 4 | 28 |
| Sodium (Latin, *natrium*) | Na | 1 | 23 |
| Sulphur | S | 2, 4, and 6 | 32 |

**Molecules and atoms.** All substances may be divided into smaller and smaller pieces, but their identity remains the same. If you take a piece of lime rock and break it into pieces like stove coal, it is still lime rock; nor does it change it if you grind it into a fine powder. There is, however, a still finer-sized particle beyond which we cannot go and have it remain limestone; this we call a *molecule*. It is composed, as the formula ($CaCO_3$) shows, of 1 *atom* of calcium, 1 atom of carbon, and 3 atoms of oxygen. If we break up this group, as when we burn lime-

stone, the separate parts have entirely different properties from the whole.

**Weights.** It is unfortunate that both molecules and atoms are too small to be seen, but their behavior leads us to adopt many positive rules as to their character. We are sure that no two kinds of atoms weigh the same, but that all atoms of any one kind are exactly alike. As they are so small, we do not attempt to actually weigh them, but only say that an atom of carbon weighs 12 times as much as one of hydrogen (the lightest known substance), that an atom of oxygen weighs 16 times as much as one of hydrogen, etc. (see table, p. 365).

**Valence.** While we cannot see the atoms or molecules, we may help ourselves by thinking of atoms as being cubes, like dice, equipped with hooks, with which they fasten on to one another to form molecules. Some, like hydrogen and chlorine, have only 1 hook; many, like oxygen, have 2 hooks; others, like nitrogen and phosphorus, have 3 hooks; and yet others, like carbon, have 4. This ability to hook up or combine is called "combining power" or *valence* (see table). Thus, a carbon atom, having a combining power of 4, will hook on to 2 atoms of oxygen each of which has 2 bonds of union. If the carbon atom has only one atom of oxygen hooked up, as in carbon monoxide (or CO), we may think of it as having 2 hooks free to grab other things and we know that it is an inflammable, dangerous gas; the carbon atom in carbon dioxide ($CO_2$), on the contrary, having all 4 hooks occupied, is a stable or strong compound, which will not burn or explode.

**Combinations.** Chemical elements have many ways of differing from each other. Like people, they have strong likes and dislikes. Oxygen has a strong liking or *affinity* for a number of the elements, and makes such strong compounds with many of them that it is difficult to separate the resulting compounds into their constituent parts. Nitrogen is almost the opposite of oxygen in its characteristics, and has aptly been called "the lazy element"; for it is unwilling to combine, and all its compounds are most unstable and readily come apart again. This unwillingness to combine especially fits nitrogen to be the principal constituent of gunpowder and other explosives, and of living things, in which there must be constant chemical change.

**Radicals.** Besides the individual atoms, there are certain groups of atoms which form partnerships or associations, which act like single atoms, going out from one compound and into another without losing their identity. These groups are called *radicals*, and might be compared to married couples or families whose relations to each other are stronger than their business associations with others. Among them, and of especial interest to farmers, may be noted the following: the radical OH, which is found in all bases, such as lime or caustic soda; the radical $SO_4$, found in sulphates; the radical $NO_3$, the form in which nitrogen is used by plants; and the radical $P_2O_5$, the most common source of phosphorus. When written, these radicals are often indicated by being enclosed in parentheses, as in $Ca(OH)_2$, the formula of calcium hydroxide.

**Acids and salts.** Compounds of a sour taste which contain hydrogen are known as *acids*. Some, such as nitric, sulphuric, and phosphoric, which are strong mineral acids, are very important. Others, such as the acetic acid of vinegar, the lactic acid of sour milk, the malic acid of the apple, and the citric acid of the lemon, are useful in our food. When one of these acids combines with a *base*, that is, a compound made of the radical OH and one of the metal elements such as iron, zinc, sodium, etc., the product is called a *salt*, without regard to its being "salty" to the taste. Thus, if nitric acid is put on caustic lime, nitrate of lime is formed; or, if soda is put in sour milk, the lactate of soda remains in the milk.

## The Chemistry of the Soil

A proper control of the chemical composition of the soil is the most important factor of permanently successful agriculture. Dr. Liberty H. Bailey gives as one of the four qualifications of a good farmer that he leave his farm in as good a state of fertility as he found it, or better. Farming is an exception to the rule that we cannot eat our cake and still have it; for, after a farmer has taken as many crops from a field as a conjurer takes articles from a silk hat, he may leave it, if he knows how, richer than he found it.

Despite this alluring possibility, it is true that agriculture usually declines. Low yields were the rule all through Europe in medieval times, and George Washington wrote to an English friend of the worn-out soils already common in northern Virginia. Every well-informed farmer knows that many, if not most, of the soils of the United States have declined in fertility, although we here and there find brilliant exceptions to the rule. Too often the American farmer agrees with the elderly farmer from a middle-western state who refused

to listen to a teacher of agriculture, saying, "You can't tell me anything about soil. I have worn out two farms already."

In western Europe, we find the crop yields about double the average of those in the United States, and, what is more significant, the last 60 years have seen an improvement there about equal to our total yield per acre. In Rome in the first century A. D., the yield of cereals was but fourfold, or 8 to 10 bushels per acre.

Many facts could be cited to prove that we have not yet adopted a permanent system of agriculture in the United States and that other countries with older soil have better methods. It is true that more labor is expended on crops in Europe than in America, but this is more than offset by our use of better machines and more horses and by the newness of our soil. The larger yields of European farms must be credited to the fact that the farmers feed their soil much more generously and skillfully.

Two centuries ago, farmers thought that the soil itself entered and fed the plant; but the true facts were most clearly set forth by Liebig in 1859, when he said, "It is not the land itself that constitutes the farmer's wealth, but the constituents of the soil which serve for the nutrition of plants." Wherever this principle has been heeded, and the soil fed freely with the necessary elements, progress has been steady. Previous to that discovery the average farmer knew nothing of purchased or commercial fertilizers; since then the fertilizer trade in America alone has grown to $100,000,000 a year.

Events from 1914 on have demonstrated the imperative need of increased crop production. This can be secured by one or both of two methods: (1) we can increase our acreage by the use of still more labor-saving machinery and extensive methods; or (2) we must raise more to the acre. That most of the desirable crop land is now in cultivation is shown by the fact that the acreage of land in farms is almost stationary, so that any great increase of crops must come about as a result of better fertilization and more intensive methods.

In order that we may take stock of what materials we have in our soil, and of what materials we need in our plants, we may set down in parallel columns the chemical elements of each class in the order of their abundance:

| IN THE EARTH'S CRUST | | NEEDED BY PLANTS | |
|---|---|---|---|
| Element | Per cent | Element | Approximate per cent |
| Oxygen (O) | 47.17 | Carbon (C) | 45.0 |
| Silicon (Si) | 28.00 | Oxygen (O) | 42.0 |
| Aluminum (Al) | 7.84 | Hydrogen (H) | 6.5 |
| ........ | ........ | Nitrogen (N) | 1.5 |
| Iron (Fe) | 4.44 | Potassium (K) | 2.0 |
| Calcium (Ca) | 3.42 | Calcium (Ca) | 1.0 |
| Potassium (K) | 2.49 | Phosphorus (P) | .5 |
| Sodium (Na) | 2.43 | Sulphur (S) | .4 |
| Magnesium (Mg) | 2.27 | Magnesium (Mg) | .4 |
| Hydrogen (H) | .23 | Iron (Fe) | .04 |
| Carbon (C) | .19 | Sodium (Na) | .4 |
| Sulphur (S) | .11 | Chlorine (Cl) | .6 |
| Phosphorus (P) | .11 | Silicon (Si) | 2.00 |

It will be seen that nitrogen does not occur in the earth's crust. However, the plant secures this element, together with its carbon, indirectly from the air, while water supplies the oxygen and hydrogen it requires. The three last-named elements in plants, namely, sodium, chlorine and silicon, are not considered necessary to their growth; and iron, magnesium and sulphur are seen to occur in soils in sufficient abundance. This leaves, therefore, only 4 elements, namely, nitrogen, phosphorus, potassium and calcium (or, as its compounds are called, lime), which must frequently be supplied in order to bring the amounts in the soil up to the point required to meet the needs of plants.

As these elements do not form more than 3 pounds in 100 of a green plant, many feel like a farmer friend of mine, who said that, if nature gave 98 pounds, he would be a stingy man to begrudge the other two. However, to supply even those intelligently, we should know as much as possible of what is in the soil and how much is removed by the crops grown upon it.

**Chemical analysis.** For upward of 50 years it has been the dream of the chemist and farmer alike that the soil could be analyzed, its precise needs determined, and the necessary fertilizer added to give any desired effect. Many people still believe this to be possible, and submit samples of soil for chemical analysis. It is no more possible to reduce

our farming to a formula than it is to have a doctor sample our blood and give us an absolute specific for all body ills. On the other hand, we can no more declare chemical analysis to be worthless than we can dispense with the doctor's diagnosis.

Since soil is mostly rock fragments and plant remains, and because certain rocks are widely scattered and abundant, it follows that a great many soils of differing farm values are very much alike in composition. Their differences are due to site, contour, exposure, hilliness, climate, rainfall, distance from market, etc. Moreover, there are great areas of soils so similar in origin and quality as to be classed as *soil types*, many of which have been carefully studied and their characters and wants fully shown.

Any soil which is in any way notable for richness or for unproductiveness will usually show the reason in its composition, and to the shrewd and resourceful farmer, suggest, on the one hand, its adaptability or, on the other hand, a suitable remedy for its condition.

If any element is really lacking, chemical analysis will show the fact and the remedy; but, if all essential elements are present in abundance, then the farmer must devise some physical means of making the soil productive, by tillage, drainage, irrigation, etc.

The soils of many large sections of the country have been studied, classified, and mapped (see Volume II, Chapter I); and the resourceful farmer should learn through the Bureau of Soils of the United States Department of Agriculture, what is actually known about the soils of his immediate neighborhood.

In general, it may be said that most of the country east of the Appalachian Mountains lacks lime, and much lacks phosphorus also; while little, except swamp land and muck or coastal plain sand, is in need of potash.

The soils of the central states need phosphorus most, and in many places need lime to a slightly less degree. West of the Mississippi River, water is more often the limiting factor than any one of the fertilizing elements.

**LIMITING FACTORS.** With a knowledge as to the composition of the soil and the plant, it is apparent that though proper culture be given, and rain and sun be normal, there will be in all probability some one of the necessary plant foods which the plant fails to secure in proper amount. This is called the *limiting factor*. It often occurs that an inexpensive substance thus limits the yield, which can then be increased to a profitable figure at slight expense.

It may be, for example, that there is in a soil plenty of everything for a 30-bushel wheat crop except phosphorus, but of this one, necessary element there is only enough for 15 bushels. The wheat is, therefore, unable to exceed this limit, while a small application of a phosphate fertilizer will raise the yield. At this point, perhaps, lack of available potash or nitrogen becomes the hindrance to still further development.

I have seen Indiana river bottoms where the purchase of phosphorus for grain gave an increase of 1,000 per cent of the cost; but at this point nitrogen became the limiting factor, and, at market prices for the grain and fertilizer, a yet larger crop was produced at a loss.

It is the farmer's business to find the limiting factors and to raise the yield to just the point where further gain costs more than it is worth. Such a limit is readily reached, and, when found, should not be exceeded until a rise in the price of the product sets a new one.

For example, with wheat at 80 cents a bushel, there is no incentive to apply fertilizer to wheat; at $1 a bushel, some phosphorus may be profitably used; but with wheat at $2 a bushel, a much larger amount of complete fertilizer, containing nitrogen, phosphorus and potash, will have a profitable result. Under normal conditions of soil, crop, and price, a farmer should keep his soils supported with the necessary lime, phosphorus, and potash for full yields, allowing nitrogen to be the limiting factor, and supplying only as much of this element as can be secured by crop rotation and the careful use of farm manures.

**NITROGEN.** The reason for making nitrogen the limiting factor of farm crops is that it costs from 4 to 6 times as much per pound as potash or phosphorus, besides which it cannot be stored in the soil in an available form. With the market price of nitrogen from 20 to 30 cents a pound, we should carefully consider the problem from all standpoints.

Nitrogen occurs free in the air in great quantities, there being, at market prices for the nitrogen fertilizer, more than $50,000,000 worth above each acre. Because nitrogen is so inert or lazy, this supply is not at all available to most plants, and only slightly available to the legumes until it is fixed or fastened down in compounds.

In ordinary soils, nitrogen occurs in amounts varying from 200 or 300 pounds to the acre in poor sandy soil, up to 8,000 or 10,000 pounds in very fertile, new, prairie soils. This is in the form of partly decayed plants or other organic matter, and not over 2 or 3 per cent of it may become available during a crop-growing season. There are nitrogenous fertilizers of many sorts on the market, differing in their content of nitrogen and in the readiness with which it is available. If the material comes from animal or plant, it is called "organic"; if not, "inorganic."

**Nitrate of soda.** Of the materials used, the principal one is nitrate of soda, in which the nitrogen is the most quickly available. This is the great stand-by of gardeners and others who wish quick results, as it penetrates deeply into the soil, is more fully recovered than other forms, and leaves the soil less acid by reason of the residue of soda. Nitrate of soda contains about 16 per cent of nitrogen, and is

often used on wheat and grass as well as on garden vegetables. It hastens growth, but often delays maturity, so it should be used at the beginning of the season and in small amounts. From 100 to 200 pounds per acre is often used on grass and grain, while intensive gardeners may find it profitable to use 400 pounds to the acre in 3 or 4 applications. It is usually applied broadcast, and never plowed under.

**Sulphate of ammonia.** This contains 20 per cent of nitrogen, and is a by-product of gasworks. It is not widely used in this country, although it is richer in nitrogen than any other material. It leaves the soil acid, and is not so fully recovered by plants as nitrate of soda.

**Dried blood.** The favorite of skilled truck gardeners is dried blood, as it is almost as quickly available as nitrate of soda, and is not so quickly washed out of the soil by rains. Its effect on the soil is excellent and it does not harm the plant. It is usually spread and harrowed in before the crop is planted, but in growing potatoes it is usually applied in the row with the seed.

**Tankage and dried fish.** These dried animal products contain phosphorus in addition to 6 or 8 per cent of nitrogen. Both are good for corn, as the food becomes available gradually rather slowly throughout the season.

**Legumes and nitrogen.** All of the above mentioned sources of nitrogen are high in price, limited in quantity, and temporary in their effect, while the great source of nitrogen, the air, remains untouched. Nearly every farmer knows that certain plants (legumes), as the pea, lupine, clover, alfalfa, vetch, and bean, leave the soil richer than they found it. I have raised 3 crops of alfalfa a year for 15 years on a field without manure, and at the end of the period have found it richer, as shown by its ability to raise better corn, than it was at the beginning. When soil is baked to kill all bacteria, a legume grown in it has no more power to take nitrogen from the air than has wheat or cabbage, but must take the supply of nitrogen from that already in the soil, leaving it the poorer. On the other hand, if the right kinds of bacteria are present, and the soil has the necessary minerals, the legume forms a partnership with the bacteria, in which the plant provides a shelter and plenty of nutritious sap containing some of the sugar made in the leaves, while the bacteria draw from the air of the soil nitrogen enough for themselves and some over to pay for their lodging. The presence of these bacteria may be known by the swellings or nodules on the roots of the legume. These nodules are not the bacteria, but merely swellings of the plant tissue within each of which thousands of the bacteria live.

It is important to know that bacteria from red clover are of no value to alfalfa, neither are those of beans capable of fixing nitrogen in soy beans or vetches. If a certain legume crop has been long and successfully grown, there is small chance of the soil lacking the proper strains of bacteria; but if a new crop, as soy bean or vetch or alfalfa, is introduced, some provision should be made for inoculation with the proper bacteria, to enable the new plant to fix nitrogen.

Soil inoculation is no more mysterious than putting yeast in bread, and is more easily done by any one of several ways. Several reputable companies, as well as many of the state experiment stations, now send out pure cultures on sand or in gelatine which may be mixed with the seed just previous to sowing. After this has been done once, the effect seems to be permanent, and there will still be plenty of bacteria when the crop is sown again. A useful method employed by many farmers is to go to some field where the crop is growing and take a quantity of soil amounting to 100 or 200 pounds for each acre they wish to sow. This soil should be sown on the field on a cloudy day or just at sunset and promptly harrowed in, as exposure to bright sunshine for even a few minutes will kill the bacteria in the soil as surely as it will those in a dairy utensil. Either of these methods will repay the labor and cost many times over.

The amount of nitrogen fixed from the atmosphere by an acre of legumes is usually given at from 40 to 160 pounds, but in some cases it is certainly higher. In the alfalfa field on my own farm (of which I spoke above) the amount removed in the hay was at least 50 pounds per ton (or 200 pounds per acre) a year for 15 years; and, as the crops and color of the soil showed as much nitrogen at the end of the period as at the beginning, I feel sure that at least 200 pounds per acre was added to the farmer's supply. This agrees with some recent, exact experimental work in which it was found that a crop of winter vetch planted in a crop of cowpeas or soy beans and followed by another, added 200 pounds per acre a year, of which, if fed to livestock, three fourths might be recovered in the manure and used to grow cereals. Figured in this manner, 2 acres of cereals may be grown on the nitrogen in the manure from 1

FIG. 325. White clover plant showing root nodules containing nitrogen obtained from the air and stored up by bacteria.

acre of a vigorous legume crop. The only manner in which a farmer can hope to maintain and increase the nitrogen supply of his farm is to grow legumes on all possible areas in all the intervals between grain crops, and, after feeding them to thrifty animals, to return to the soil the entire product of the manure. While unusual prices for grain may justify the use of nitrates, yet in the long run Dr. Cyril Hopkins of Illinois is correct when he says, "The American farmer can sometimes afford to buy water to irrigate his grains, but not to buy nitrogen to fertilize them." The truck or cotton farmer may buy nitrogen with profit, but the general farmer will do well to follow the experience of the oldest agricultural countries and the teachings of the youngest experimenters and produce his own nitrogen on the farm by the aid of the friendly bacteria.

There are still other bacteria in the soil which do not live on legumes, but which have the same power of fixing nitrogen from the air. These live on decaying plants and are encouraged by stable manure, lime, good drainage, and thorough tillage. In thin, poor, acid soils they are of very little account; but in fertile, well-manured soils they may, in some cases, add as much nitrogen as those of legumes, because they are always at work.

**Lime.** Lime is a name which is applied to several compounds of the element calcium, with the result that many persons are confused as to their identity and value. To begin with, calcium is a light-weight, silvery white metal, much softer than iron and somewhat resembling tin in color and hardness. It is seldom seen outside of large laboratories, and has few uses. Calcium has such a strong affinity for oxygen that it readily burns, to form the oxide $CaO$, and will even pull the molecules of water apart to get oxygen. You will recall that oxygen and hydrogen often unite, to form a radical (OH), which acts like a single atom, leaving one compound and entering another unchanged. When calcium comes into contact with water, we may picture the water as being composed of an (OH) radical loosely fastened to one atom of hydrogen, or H (OH) (instead of $H_2O$, the usual way of writing it). The hydrogen is given off as a gas, and the calcium atom combines with two of the (OH) radicals to make slaked or hydrated lime, $Ca(OH)_2$. This form of lime is an active, soluble base, or alkali, with the power to combine with and neutralize all acids. One of the most abundant acids in nature is carbonic acid, or carbon dioxide, which combines with this caustic lime and forms a salt of lime which we call "carbonate" ($CaCO_3$).

I have now traced through from the metal the principal compounds of lime, to show their relation to each other; but the manufacture and application of lime begin with the carbonate and go the other way. When we quarry limestone, it is a carbonate of lime, $CaCO_3$, often mixed with carbonate of magnesium, $MgCO_3$, a substance with rather similar properties. If we heat or burn this lime rock, its molecules break up and let the carbon dioxide go off as a gas, leaving the calcium oxide as a white solid. Thus $CaCO_3$ becomes $CaO + CO_2$. If the lime rock is pure, 100 pounds lose 44 pounds of carbon dioxide by burning. Calcium oxide, or quicklime, is familiar to everyone who has whitewashed, or mixed plaster, or done disinfection on an extensive scale, or made lime-sulphur solution or Bordeaux mixture for spraying. When water is put on, the quicklime combines directly with it, giving off much of the heat which was absorbed when the limestone was burned. Thus $CaO + H_2O$ becomes $Ca(OH)_2$. Fifty-six pounds of pure quicklime takes up 18 pounds of water, making 74 pounds of caustic, or hydrated, or slaked, lime. As the calcium is unchanged, we find that 100 pounds of limestone is equal to 56 pounds of quicklime, or 74 pounds of hydrated, or slaked, lime. When this is exposed to air, which contains the usual amount of carbon dioxide, the gas is absorbed, making carbonate of lime and water. Thus $Ca(OH)_2 + CO_2$ becomes $CaCO_3 + H_2O$. This takes considerable time, but in the end the lime will become the same carbonate with which the cycle started. When lime is mixed with sand for plaster it hardens because the carbonate of lime crystals lock the sand grains together into an artificial sandstone. Water is given off when this takes place, which accounts for the dampness of newly plastered houses.

Carbonate of lime is very slightly soluble in water; but in the soil it combines with another part each of water and carbon dioxide, making soluble bicarbonate of lime, which is the most common cause of "hard water." This has much the same chemical relation to carbonate of lime that baking soda has to washing soda. When very hard water is exposed to the air and sun's heat, it often drops a part of its lime as a crust on twigs or moss, making a form of petrified moss, etc. This process partly accounts for the fact that lime washes out of a fertile soil more rapidly than other plant foods, such as potash.

A study of the weights and reactions will also show that the question of what kind of lime to buy is mostly one of which kind gives the most pounds of calcium for a dollar. No matter which kind is used, the result is much the same. The use of quicklime saves freight, because 56 pounds of it is equal to 100 of limestone; but, unless used at once, it absorbs moisture and bursts all barrels or sacks. The hydroxide has better keeping qualities and is finer than grinding can make it, but when put in the ground it soon becomes carbonate.

Not all of the chemical changes of lime are included in the above, for the element calcium seems to take an important part in

much of the chemistry of the farm. If we use sulphate of ammonia as fertilizer, we find that the molecule $(NH_4)_2SO_4$ breaks up; the $NH_4$ being used by the plant, and the sulphate radical $SO_4$ remaining in the soil as sulphuric acid. This acid makes the soil sterile unless enough lime is present to combine with the acid and make insoluble gypsum, or calcium sulphate ($CaSO_4$), just as it does in Bordeaux mixture.

It is, therefore, necessary to know the source as well as the amount of nitrogen in fertilizers, in order to replace the lime that has been made insoluble and to keep a supply available for plant food. This is not an argument against sulphate of ammonia, because nitrogen is the expensive food and lime a very cheap one. The important thing is to know what we are doing and to provide for the consequences of our actions.

Nitrate of soda has certain chemical effects directly contrary to those of sulphate of ammonia, as a study of its chemistry will show. Its formula is $NaNO_3$, of which the nitrate radical ($NO_3$) is used by the plant, which leaves the sodium, Na, in the soil. Now sodium, like calcium, is an alkali-forming element which decreases the acidity of the soil by that amount. If lime and sulphate of ammonia are mixed, the lime will draw the sulphate radical to itself and the gaseous ammonia will escape. This change is shown thus: $(NH_4)_2SO_4+Ca(OH)_2$ becomes $CaSO_4$, or gypsum, and $2NH_4(OH)$. Any substance that contains ammonia is affected in this way, the ammonia being driven off. Anyone who knows the odor will appreciate the "know-it-all" farmer who told me that he always mixed his wood ashes (50 per cent lime) with his hen manure. I remonstrated; but he said, "I know it makes the manure stronger, for I can smell it." The opposite effect is produced when gypsum is mixed with decaying manure. The carbon dioxide, ammonia, and gypsum unite to form carbonate of lime and sulphate of ammonia, thus: $CaSO_4+2NH_4(OH)+CO_2$ becomes $CaCO_3+(NH_4)_2SO_4+H_2O$.

**Phosphorus.** The element phosphorus is opposite in a chemical sense to calcium, as it is waxlike instead of metallic, and its oxides form acids instead of bases. It is more like beeswax than it is like any other common substance. It has such a strong attraction for oxygen that it will take fire in warm air and smoke in cold air, making it necessary to keep it under water. It burns readily, giving off a dense white smoke which is, of course, an oxide. This has been found to be $P_2O_5$, the *phosphoric pentoxide* of the chemist. This dissolves in water, making real phosphoric acid, $H_3PO_4$, though the name is generally applied to the dry acid or powder produced by burning the phosphorus. This acid would destroy any plant at once, so it is used in the form of a salt, or phosphate, made by combining the acid with a base or alkali. The most common one with which it is combined is calcium, in which form (phosphate of lime) it is usually found in nature. This mineral is widely scattered, forming a part of every fertile soil. It occurs in large accumulations of phosphate rock in South Carolina, Florida, Tennessee, and several of the Rocky Mountain states, but, whether in rock or in the form of bone, it is the same compound of 3 parts of lime (CaO) to 1 part of dry phosphoric acid ($P_2O_5$). Looking back at the weight given in the general discussion of chemistry, we find that the 3 parts of lime are slightly heavier than the phosphoric acid, making the lime six elevenths or 55 per cent of the whole, and the phosphoric acid five elevenths or 45 per cent of the whole. As found in nature, it is not often more than 60 or 80 per cent pure, bringing the actual phosphoric acid down to 30 or 35 per cent.

When found combined with 3 parts of lime or, as it is called, "tricalcium phosphate," none of the phosphoric acid is soluble, though certain crops, such as buckwheat and soy beans, can use it. In order to make the rock more soluble, chemistry has been applied, and we use what is known as acid phosphate or superphosphate. To obtain this phosphoric acid or superphosphate, rock or bone is mixed with an equal weight of strong sulphuric acid ($H_2SO_4$) and allowed to stand for a number of days, or until chemical action stops. There are present 2 acids and only 1 base. The stronger acid, the sulphuric, combines with most of the lime, making $CaSO_4$, or gypsum, which is insoluble; but the phosphoric acid in combination with 1 part of lime is entirely soluble and can be used by the crops. There is a small amount of the phosphate left, in which 2 parts of lime remain. This is called "dicalcium," or "reverted phosphate"; it is not soluble in water, but it can be dissolved by the root juices. We have, then, three forms of phosphate, containing respectively 3, 2, and 1 parts of lime to each part of phosphoric acid. These have been represented thus:

$$1\left\{\begin{array}{l}\text{Lime}\\ \text{Lime}\\ \text{Lime}\end{array}\right\} + \text{Phosphoric acid} = \text{Insoluble or tricalcium phosphate.}$$

$$2\left\{\begin{array}{l}\text{Lime}\\ \text{Lime}\\ \text{Water}\end{array}\right\} + \text{Phosphoric acid} + \left\{\begin{array}{c}\text{One part of lime}\\ \text{sulphate or}\\ \text{gypsum.}\end{array}\right\} = \text{Dicalcium or reverted phosphoric acid.}$$

$$3\left\{\begin{array}{l}\text{Lime}\\ \text{Water}\\ \text{Water}\end{array}\right\} + \text{Phosphoric acid} + \left\{\begin{array}{c}\text{Two parts of lime}\\ \text{sulphate or}\\ \text{gypsum}\end{array}\right\} = \text{Acid phosphate or superphosphate (water soluble).}$$

**The last two together are classed as available phosphoric acid. The advantages of the different forms are easy to understand.**

Rock phosphate has twice as much phosphorus as acid phosphate, and costs only half as much per ton, making the real element phosphorus cost only one fourth as much. Acid phosphate, on the other hand, has nearly all of the phosphorus available and most soils of eastern United States gives much quicker returns when it is used.

The sulphate of lime, or gypsum, in acid phosphate is not injurious, and may serve a useful purpose in stable manure by changing to sulphate of ammonia and limestone, thus saving the expensive and volatile nitrogen.

Soil which is deficient in lime is nearly always poor in available phosphoric acid, as in such a soil the phosphorus is in chemical combination with the iron or aluminum of the soil. These phosphates are less useful than calcium phosphates. A test of the soil showing acidity always points to the use of soluble acid phosphate for "first aid," and a larger application of lime, rock phosphate, and organic matter for its permanent upbuilding.

Phosphorus is also secured from dried fish and animal tankage, both of which have about 5 per cent of phosphoric acid with 7 to 10 per cent of nitrogen. Basic slag is made of the finely ground linings of the steel converters in which the lime has attracted the phosphorus away from the iron. Basic slag is quite variable, but the phosphoric acid seems almost, or quite, as available as that in acid phosphate; in addition, slag contains a large amount of lime, usually 50 per cent.

The solubility of the soil phosphates is greatly increased by the presence in the soil of plenty of decaying vegetable matter, the effect probably being due to the bacteria of decay which act on the phosphates and cause them to combine chemically with the humus.

It has been recently proved that when sulphur is mixed with the soil, the bacteria cause it to change to oxide of sulphur and, finally, to sulphuric acid. As this is the acid which makes phosphate rock soluble, the experiment has been made of putting both rock phosphate and sulphur in a compost heap, with the result that the soil became much richer in available phosphorus, as shown by both chemical tests and crop records. This method is expected to prove of most value to truck growers who can make compost heaps.

In one important respect, phosphorus differs from potash. There is no large reserve of it in ordinary soils, to be set free by lime or by other treatment. Most of the soils of the United States contain so little that 100 full crops would seriously deplete the supply, while many soils have not enough phosphorus to give 25 crops without cutting down the reserve lower than Nature will allow. It is, therefore, a problem of how to buy enough for maximum crops and keep it in available form for plants to use. Much of the most valuable phosphorus in the soil is in an intricate chemical combination with the organic matter or humus, thus making three factors in maintaining an available supply: (1) we must add it to practically all soils; (2) lime must be present to keep from combining with the iron or aluminum; (3) organic matter is needed, to hold it in available form, and by its decay change it from insoluble tricalcium to soluble forms.

**Potash.** Potash is needed by all plants; and as the supply in the soil is tied up in very complex and insoluble silicates, we often need to apply a soluble form, in order to give our plants enough for a full crop. The value of a fertilizer depends not only upon what plant food it brings, but upon what else it leaves in the soil after the plant food is gone. If we could employ nitrate of potash, $KNO_3$, it would all be used, leaving no residue; but cost forbids, so we use muriate of potash, $KCl$, or sulphate of potash, $K_2SO_4$, each of which contains about half potash. If we use the sulphate of potash, $K_2SO_4$, there is left the $SO_4$, as in sulphate of ammonia, which will use up some of the lime and be insoluble. If we use the muriate of potash, $KCl$, the chlorine will remain, to combine with the lime and form a highly soluble substance, calcium chloride, $Ca(Cl)_2$, which will disappear in the drainage water. In either case, the use of potash reduces the supply of lime, or, if there is no lime, increases the acidity of the soil to the point of ultimate unproductiveness. As has been observed, calcium and potassium are quite similar chemically, and one may be substituted for the other, like Damon and Pythias in the old story. Our soil contains potash in the unusable form of a silicate of potash. Where lime is added to the soil, a certain amount may replace the potash, forming a silicate of lime and free potash.

**Commercial fertilizers.** In no way does the farmer make more use of his knowledge of chemistry than in the purchase and use of commercial fertilizer. The man who feels sure he knows no chemistry is at the mercy of the manufacturer or dealer whose interest it is to sell him the least possible plant food for the largest possible price. Examples of the gullibility of farmers are found in the names of brands, as "Queen of the Harvest," "Wheat King," etc. It is the custom to use finely ground coal cinders as filler, because farmers think a black fertilizer is rich; and the repetitions on the tag give the buyer the idea that there are in it a dozen, instead of three, fertilizing ingredients.

The question is simply one of buying the most pounds of phosphorus, nitrogen, and potash for a dollar, basing the proportions of the three on the amount and solubility of the stores already in the soil, rather than on the needs of the crop.

We laugh at the simplicity of the man who patronizes a particular physician because he gives so much dark-colored bitter medicine, and yet feel complacent because we have dosed our soil with 200 or 400 or 600 pounds to the acre of a fertilizer which the seller asserted loudly to be the "best on earth." Fortunately the law now requires all fertilizers to be clearly tagged, so that the buyer who wishes to can know what he buys. As the composition of these materials has been thoroughly discussed, it only remains to study the practice of buying and estimating values.

In practice there are just two problems to be faced: (1) What is a fertilizer of given analysis worth? (2) What can I mix, to get the composition I want?

Failure to answer these questions costs the farmers of the United States millions of dollars each year. When reading the tag, look for just three items: first, nitrogen; second, available phosphoric acid; and, third, soluble potash. Multiply each one by 2,000 and then by the value per pound given in your state experiment station bulletin for the current year, which can always be obtained free of charge.

It is often found that the amount of nitrogen is given in terms of ammonia, to make it sound better. If this is done, we should recall that ammonia is $NH_3$; then, by looking back at the table of elements, we find that an atom of nitrogen weighs 14 and each hydrogen atom weighs 1. Now, by giving them their weights, we find $14+3=17$, of which 14 parts, or fourteen seventeenths, are nitrogen. If the substance has 5 per cent of ammonia, we say 5 per cent of a ton is 100 pounds, and $^{14}/_{17}\times 100$ equals very nearly 83 pounds of nitrogen to the ton.

If we get prices on tankage, we find, in some cases, that the phosphorus is given in terms of bone phosphate of lime, in which form it actually does occur. Now this substance is the same as in rock phosphate, $Ca_3(PO_4)_2$, or tricalcium phosphate. We have our other phosphorus fertilizers in terms of phosphoric acid, so let us put the chemical weights in the place of the chemical symbols:

$$Ca_3(PO_4)_2.$$
$$120+62+128=310$$

The weight of $P_2O_5$ is $62+80$, or 142. Therefore we may say that one hundred and forty-two three-hundred-and-tenths or about 46 per cent of the bone phosphate of lime is phosphoric acid. One of the most-used fertilizers is called a 2–8–2, as it contains 2 per cent of nitrogen, 8 per cent of phosphoric acid, and 2 per cent of potash. Such a mixture can be made of 1,300 pounds of good materials, leaving 700 pounds to be made up of worthless filler, as cinders or other material. This filler requires bags, costs freight, haulage, and distribution, and is used simply to give a cheap purchaser a lot for his money.

If several grades are offered, you will be surprised to find that fertilizers of the highest grade usually supply the most plant food for a dollar. Those fertilizers containing 4 per cent of nitrogen or more are high-grade, and those containing less than 3 per cent are low-grade. The nitrogen of fertilizers containing 4 per cent or more is certain to be of high availability, in the form of dried blood, nitrate of soda, tankage, or fish; while fertilizers with 1 or 2 per cent of nitrogen may supply it as dried garbage, swamp muck, or some other less valuable forms.

Let us assume you decide to use a fertilizer containing: nitrogen 4 per cent, or 80 pounds in a ton; available phosphoric acid 10 per cent, or 200 pounds in a ton; potash 3 per cent, or 60 pounds in a ton.

On a staple, full-season crop, such as potatoes, it would first be necessary to consider the sources. Two sources of nitrogen should be taken, one available early in the season, the other more slowly. These are found in nitrate of soda and high-grade tankage. Four per cent of a ton is 80 pounds, of which half is to come of nitrate of soda with 16 per cent nitrogen; 40 pounds divided by 16 per cent gives 250 pounds as the proper amount of nitrate of soda. The other 40 pounds is to come from tankage containing 8 per cent nitrogen, or 500 pounds. The tankage contains 5 per cent of phosphoric acid, or 25 pounds in all, reducing the total to be secured from 16 per cent acid phosphate to 175 pounds. One hundred and seventy-five pounds divided by 16 per cent gives a little over 1,000 pounds as the quantity necessary to supply the phosphoric acid. The 60 pounds of potash will come from the sulphate containing 50 per cent actual $K_2O$ or, since the material we buy is

half potash, we get twice as much, or 120 pounds.

We now have all of the ingredients, namely: nitrate of soda, 250 pounds; tankage, 500 pounds; acid phosphate, 1,000 pounds; sulphate of potash, 120 pounds; total ingredients, 1,870 pounds.

Although this lacks 130 pounds of a ton, it has all that we aimed to get, and all from high-grade materials without filler, of which many low-grade fertilizers contain from 300 to 800 pounds. Home mixing of fertilizers saves money, and gives good results in crops; but it has never been widely popular. No company cares to sell "the makings" in small amounts, while many strive to sell complete fertilizers on which there are several more dollars a ton profit; but in some sections, as eastern Long Island, clubs of farmers choose a purchasing committee which decides what formula to use and of what materials it shall be made up. Bids are then solicited, the order placed, and the company mixes the materials to order.

As in the case mentioned above, fertilizers are often spoken of by formula, as a 2–8–2, meaning 2 per cent nitrogen, 8 per cent available phosphoric acid, and 2 per cent potash. In the absence of potash, a 5–10 fertilizer is often used on potatoes or truck, and a 3–12 on corn.

Unit system of buying. The wholesale trade quotes prices on what is called the "unit basis," which simply means at so much for each per cent in a ton, or 20 pounds. To make this plain: Phosphoric acid is worth $1.60 a unit, and nitrogen $5 a unit. Tankage has a composition of 8 per cent nitrogen and 6 per cent of phosphoric acid; the 8 units of nitrogen being worth $40, and the 5 units of phosphoric acid $9.60, or $49.60 a ton for that grade of tankage.

This method should be used by all farmers who are progressive enough to buy their materials together and mix just what their experience tells them their land needs.

The form in which the plant-food elements occur is as important as their composition. Nitrogen, as nitrate of soda, is not held by the topsoil, but penetrates deeply and is more fully recovered than in the form of sulphate of ammonia. Dried blood quickly decays because of bacterial action, forming, first, ammonia, which is held by the soil water; then the ammonia is changed to nitrites, and these, in turn, to nitrates which are useful to all plants. As this change is reasonably rapid and complete, a pound of nitrogen in blood is as valuable as in nitrate of soda. Tankage decays somewhat more slowly, seeming to give just about the distribution through the season needed by corn.

Bone with 4 per cent of nitrogen decays more slowly, making it very desirable for grass and shrubbery. Fish is slower than tankage, but generally satisfactory on full-season crops. Swamp muck, peat and garbage tankage are so slow that they should not be bought at the same price as higher grade forms of nitrogen such as blood.

There is on the market one other nitrogen compound which demands attention on account of its chemistry and, possibly, its large future production. Cyanamide is made from the free nitrogen of the air by electrical energy at Niagara Falls. Quicklime (CaO) and coke (3C) are first heated to make the familiar calcium carbide used to make acetylene ($CaC_2$), the gas CO passing off. The carbide is cooled, crushed, and again heated red-hot in the presence of nitrogen or air from which all oxygen has been removed. The reaction is $CaC_2+N_2=CaN$, $CN+C$, which serves as a valuable nitrogen fertilizer reacting with the soil water to form ammonia compounds available to plants. It is also of interest since it leaves a residue of lime in the soil instead of an acid.

## The Chemistry of Plants

In the beautiful lines on the opposite page does the farmer, musician, and soldier-poet Sidney Lanier tell his appreciation of the wonderful chemistry of the corn plant as he saw it grow in the fields of Georgia.

Looked at in a less poetic way, we see in every plant a wonderful chemical laboratory where all the food in the world is made out of the products of decay. Not one bit of food exists in the world to-day except through the chemistry of the plant. We eat the product of a plant once or twice removed; we may eat the flesh of the animal, but this animal had to grow to maturity by feeding on plants.

Chemistry has made wonderful progress in the last century; but the green leaf of the plant still holds the secret of taking the carbon dioxide gas from the air, of causing it to combine with water to give us starch, sugar, or fiber, and of returning to the atmosphere the life-giving oxygen which we must have. If we take sugar or starch in a glass tube, and heat it over a flame, we

find that it gives off five ninths of its weight in water and leaves four ninths in solid black charcoal. After we have taken it apart and weighed the parts, should we want our sugar again, we would find that, as in the old rime, "All the King's horses and all the King's men, couldn't put Humpty Dumpty together again." The reason for this is that not only does the sugar contain carbon and water, but it has stored up in it a large amount of energy which it is the special province of green leaves to extract from the sun's heat.

**Chlorophyll.** When you have been walking across bare, dry ground or along a dusty road and have occasion to enter the woods or even a tall cornfield, you are grateful for the coolness. It does not often occur to you, though, to ask yourself what has become of the heat which fell on the wood or the cornfield. If, on the other hand, you walk on a railroad track, you may be almost overcome by heat, and will believe the common saying, that the rails "draw the heat." The truth of it is, however, that rails do not draw heat, they only absorb it; and, when they are hot, they reflect it again. The green leaf draws just as much heat as does the steel rail or a bright tin roof; but it never gets hot, because it has the power of using the heat to put energy into the plant substance. Here it lies latent until the digestion of an animal, or decay, or fire, sets it free again as heat or motion. While we do not know how the plant is able to store up the hot summer sunshine, we do know that the special machine with which it is done is in the green coloring matter of the leaves, which we call "chlorophyll." If we take a green leaf and dip it in boiling water to kill the cells and then dip it in alcohol, we can wash out this wonderful substance and examine it. The microscope shows it to be composed of definitely shaped particles, vivid green in color, but nothing else. The analysis of the chemist shows it to be much like the rest of the plant, containing nitrogen, carbon, water, and more iron than any other part of the plant; but, examine and analyze as we will, its secret is beyond us.

**CORN**

**Thou hast built up thy hardihood**
**With universal food,**
**Drawn in select proportion fair**
**From honest mould and vagabond air;**
**From darkness of the dreadful night,**
**And joyful light;**
**From antique ashes, whose departed flame**
**In thee has finer life and longer fame; . . .**
**From potsherds and dry bones**
**And ruin-stones.**
**Into thy vigorous substance thou hast wrought**
**Whate'er the hand of Circumstance hath brought;**
**Yea, into cool solacing green hast spun**
**White radiance hot from out the sun.**

—SIDNEY LANIER.

Plants like dodder or love vine, which suck the juices of other plants, have no chlorophyll, as they do not need to create what they can so easily steal. On the underside of the leaf there is generally less chlorophyll than on the top; and a careful examination reveals a great many stomata, or tiny openings, by which the air is able to enter the leaf. Mixed with the air is a small amount of carbon dioxide, given off by animals in their exhaled breath, by decay, by fires, and in gases given off by limekilns, and by volcanoes. As the molecules of this gas, which the chemist calls $CO_2$, come into contact with the leaf cells, they combine with the molecules of water brought up from the soil by the roots to form starch and free oxygen. This change cannot go on unless there is present enough nitrogen to build chlorophyll, as well as an abundance of certain minerals which do not seem to take part in the change, but which by their presence cause it to take place. Phosphorus, sulphur, potash, lime are all needed in this important change, although only in small amounts. As

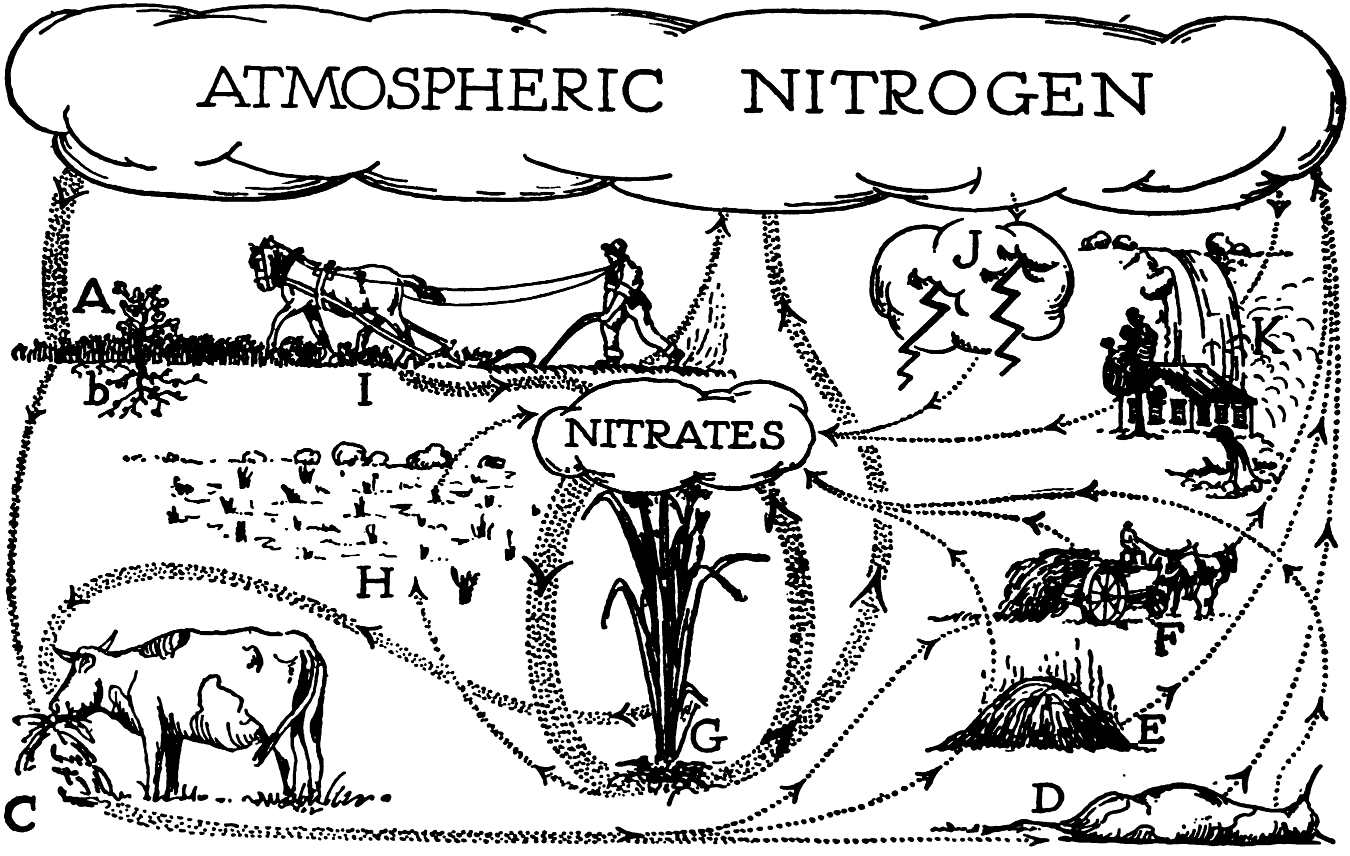



FIG. 326. Pictorial translation of Fig. 327. Note the courses nitrogen may take: through the root nodules (b) of legumes (A) and into the bodies of animals (C); through their decay (D) into the soil (where it is changed to nitrates) or back into the air; through manure piles (E) and freshly spread manure (F) both of which deliver some to the soil and lose some into the air; through the plowed-under cover crop (I); through the action of thunderstorms (J) and the efforts of man in making nitrogen fertilizers (K, see p. 374), both of which methods change the atmospheric form directly into nitrates. Note also how plants (G) taking the nitrates, may either decay and give the nitrogen back to the air and to soil bacteria, or may be eaten as fodder (C) and start the cycle anew; or, as stubble plowed under (H), may again deliver their nitrogen to be remade into nitrates and started on another journey of service. The farmer's task is to promote all those changes which hold the nitrogen in the soil, and to check those which result in the loss of nitrogen into the air.

long as the sun shines, the busy work of making starch goes on, as we can see by the presence of great numbers of starch grains in the leaf. When night comes and there is no more sunlight to use in making starch, the busy chemical laboratory of the leaf proceeds to dispose of its product.

**Starch.** Starch is a solid and can no more travel through the veins of the plant than a brick can go through a water pipe. The minerals potash, phosphorus, sulphur, and lime are again used; and the molecule of starch, which consists of 6 atoms of carbon to each 5 molecules of water, has 1 more part of water added which completely dissolves it and changes it to sugar. This sugar can freely traverse the veins of the plant to the spot where growth is taking place; and here it may again be changed to starch, if in a seed or a potato tuber, or to fiber, if in cotton. Sugar, starch, and plant fiber, or cellulose differ from each other but slightly in the proportion of water to the carbon. When the plant desires to form oil, as it does in corn and in the peanut, it does so by releasing a still larger part of the oxygen and thereby increasing the proportion of carbon and hydrogen. In fact, we may think of fats or oils as being concentrated starch. The transference of starch requires larger amounts of potash, lime, phosphorus, and magnesia than does its formation in the leaf; and, if any one of these minerals is deficient, the starch is left congested in the leaf and stems. When potatoes are raised in poor, sandy soil and fed generously on nitrogen, they make a rank growth of tops, but develop few tubers, because the plant is unable to move the starch away from the leaves. This is caused by the leaves being congested with starch, in which condition they are more easily attacked by blights and rots. This fact has an important bearing on potato growing, where such conditions are often met.

Not all the plant products are starch, sugar, or fiber; the gluten of wheat and the proteids of alfalfa being examples. These contain, in addition to the carbon, hydrogen, and oxygen of starch, about one sixth of their weight of nitrogen and small but definite amounts of sulphur and phosphorus. The manner in which these proteids are manufactured out of the sugar and the nitrates is just as mysterious as the formation of the nitrates themselves, which has been described above under "The Chemistry of the Soil." Many of these nitrogenous compounds are exceedingly complex and contain a great number of atoms. Among them may be mentioned such drugs as cocaine, morphine, caffeine, and many others.

**How roots take in plant food.** Mention has been made of the use to the plants of the minerals sulphur, potash, lime, and phosphorus taken from the soil. However, unless one has studied the subject, it is always a surprise to know what a weak solution is sufficient for the growth of the plants. Roots cannot bite off pieces of plant food as an earthworm swallows soil, but must have their food completely dissolved, so that it can be absorbed through the thin skin of the root. If you take a dried, withered prune and put

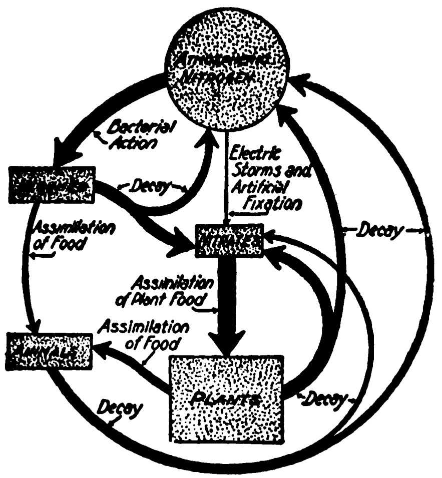



Fig. 327. The nitrogen cycle, showing how Nature transfers the element from its original source to the plant, and back again. Compare Fig. 326. (From "Foundations of Chemistry." Copyright, 1914, by A. A. Blanchard and Frank B. Wade. American Book Company, Publishers.)

it in water, it absorbs the liquid, becomes plump, and, after a time, will burst like a frozen egg. The reason for this is that there is a strong solution of sugar inside and clear water outside, which causes the water to pass through the membrane toward the denser solution. This is what happens in the root and the soil water or "soil soup," as the solution of minerals has been called. The soil soup is absorbed until the root sap is as dilute, or thin, as the solution outside. Before this can be quite accomplished, some of the water has been used and some of the minerals taken out, making the solution in the root different again and stronger than the soil water and bringing a steady stream in to the plant.

Each pound of dry substance requires from 200 to 500 pounds of water to be passed through the plant. This water comes in as a dilute solution of soil soup, leaves its minerals to work in the plant, and passes out as a vapor. This process is called "transpiration." The quantity of water thus used or transpired by a good field of corn is enormous; a good hill uses from 3 to 5 barrels during its period of growth, according to the dryness of the air. If all of the water to grow a full crop were on top of the soil at once, it would be from 15 to 20 inches deep. Much of this water is of small use to the plant, which seems, however, unable to use a strong solution. If enough soluble fertilizer is put in the soil to make the solution stronger than that in the roots, the juices are drawn out of the roots and the plant wilts. This sometimes happens when a heavy application of fertilizer is used in a dry year.

### The Effects of the Elements on Plants

Although all the elements taken from the soil are equally necessary to the growth of the plant, each one seems to have fairly distinct functions.

**Iron** is present in small amounts only; but without it the plant is pale, and cannot make chlorophyll.

**Phosphorus.** Phosphorus, besides making a part of the proteins and transferring the starch, is found in greatest amounts in the seeds. Unless an abundance of phosphorus is present, the plant may be unable to set perfect seeds. When wheat lacks plumpness, and is not up to the legal weight per bushel, it is often due to lack of phosphorus. The other cause is a disease or insect which injures the plant. If corn has a well-balanced ration of fertilizers, it gives a pound of dried grain for each pound of dry stalks; but, if it has difficulty in getting phosphorus and has plenty of nitrogen, it may give 2 or 3 pounds of stalks for each pound of grain. Phosphorus also hastens maturity and is used for this reason on cotton in the northern part of the cotton belt.

**Potassium.** Potassium is necessary early in the life of a plant and often decreases in amount as the plant matures. It is not stored in the seed to any great extent, but seems to be put away in the lower stalks, just as we put unused articles in the attic. A ripe field of corn has 9 times as much phosphorus in the grain as in the stalk and 3 times as much potash in the stalks as in the grain. For this reason, all grain-selling sections in time exhaust their phosphorus, but seldom their potash.

**Lime.** Lime is essential to growth in plants, but does not accumulate in the seeds. Plants which lack lime are usually lacking in hardiness and readily fall a prey to disease. Plants differ widely in their lime requirements. Some, like clover or peas, use three times as much lime as phosphorus, while others, such as corn, use more phosphorus than lime. Lime greatly influences the composition of leguminous plants by aiding the bacteria to secure nitrogen. Recent investigations have shown that the use of lime on soy beans increased not only the yield, but also the richness of the crop. My own observation is that limed soy beans have at least twice the feeding value per acre of an unlimed crop.

**Nitrogen.** The importance of nitrogen has been discussed, but its effect on the plant is not readily foreseen. When abundant in the soil, it promotes an undue growth of the leafy parts, making large thick leaves of a dark green color. Maturity is always delayed beyond the usual time; and if too much is supplied, the amount of seed may be reduced. An excess of nitrogen in fruit trees makes too much wood growth and delays the ripening of the wood, so that winter injury may result. It also tends to make large, poor-colored, acid fruit, and increases the tendency to fungous disease. Wheat is a crop that seems to lack ability to secure its own nitrogen, and for that reason it gets most of the purchased nitrogen on a general farm. As rapid, succulent growth is desired in many garden crops, a great deal more nitrogen may be profitably used in the garden than elsewhere. The amounts of some of the foods used by plants, as determined by chemists, are shown in the table at the top of the opposite page.

PLANT FOOD REMOVED BY CROPS IN POUNDS PER ACRE

| Crops and Yields | Gross weight | Nitrogen | Phosphoric acid | Potash | Lime | Silica | Total ash |
|---|---|---|---|---|---|---|---|
| Wheat, 20 bushels | 1,200 | 25 | 12.5 | 7 | 1 | 1 | 25 |
| Straw | 2,000 | 10 | 7.5 | 28 | 7 | 115 | 185 |
| Total | | 35 | 20 | 35 | 8 | 116 | 210 |
| Barley, 40 bushels | 1,920 | 28 | 15 | 8 | 1 | 12 | 40 |
| Straw | 3,000 | 12 | 5 | 30 | 8 | 60 | 176 |
| Total | | 40 | 20 | 38 | 9 | 72 | 216 |
| Oats, 50 bushels | 1,600 | 35 | 12 | 10 | 1.5 | 15 | 55 |
| Straw | 3,000 | 15 | 6 | 35 | 9.5 | 60 | 150 |
| Total | | 50 | 18 | 45 | 11 | 75 | 205 |
| Corn, 65 bushels | 2,200 | 40 | 18 | 15 | 1 | 1 | 40 |
| Stalks | 3,000 | 35 | 2 | 45 | 11 | 89 | 160 |
| Total | | 75 | 20 | 60 | 12 | 90 | 200 |
| Peas, 30 bushels | 1,800 | | 18 | 22 | 4 | 1 | 64 |
| Straw | 3,500 | | 7 | 38 | 71 | 9 | 176 |
| Total | | | 25 | 60 | 75 | 10 | 240 |
| Mangels, 10 tons | 20,000 | 75 | 35 | 150 | 30 | 10 | 350 |
| Meadow hay, 1 ton | 2,000 | 30 | 20 | 45 | 12 | 50 | 175 |
| Clover hay, 2 tons | 4,000 | | 28 | 66 | 75 | 15 | 250 |
| Potatoes, 150 bushels | 9,000 | 40 | 20 | 75 | 25 | 4 | 125 |
| Flax, 15 bushels | 900 | 39 | 15 | 8 | 3 | 0.5 | 34 |
| Straw | 1,800 | 15 | 3 | 19 | 13 | 3 | 53 |
| Total | | 54 | 18 | 27 | 16 | 3.5 | 87 |

**Plants injured by gases.** If an animal likes a certain place, it can stay there and avoid an unpleasant, unhealthful, dangerous neighborhood; but the plant is not able to move, and is more easily influenced by a bad chemical condition in the air or soil. The leaf has to be of a very open texture to admit enough air to supply the carbon needed. It is, therefore, readily injured by noxious gases. Smoke is apt to clog the pores of the leaf, and even dust from a highway will affect the plant on which it accumulates. It is a great advantage for a plant to be able to shake itself free of dust, and to this end the dashing rains of summer do more than water the roots. Gases often poison the leaf, as everyone knows who has tried to keep house plants in a room where artificial gas is burned. I have seen a large modern greenhouse made useless for two years because gas from a leak in the main across the street came under the frozen ground all winter. Although the odor was never perceptible to the workmen, none of the plants bloomed, and sensitive ones died outright. In Butte, Montana, the copper smelters give off enough sulphurous acid to kill vegetation about the works. Roses seldom thrive as well in the great manufacturing cities as they do in the open country, where they are free from the poisonous chemical compounds of the smoke-laden city air.

If plants are sensitive to chemicals in the air, which changes constantly, they are doubly sensitive to chemicals in the soil, which is in contact with their roots. We often employ soluble forms of arsenic to exterminate grass and weeds from our walks, roads, and tennis courts. A mixture of 1 pound of white arsenic boiled with 2 pounds of washing soda and diluted to make 7 gallons, is as violent a poison to plants as it is to animals. The arsenic used for spraying fruit trees does no harm because it is insoluble. Strong acids make the soil permanently sterile. I saw a spot on a farm in northern Virginia where no plant had grown since the Civil War, at which time a wagon broke down there, spilling the sulphuric acid ($H_2SO_4$) used in filling an observation balloon. All the rains of 50 years had been unable to wash this acid out of the soil.

**Small amounts of acid food for certain plants.** Small amounts of acids in the soil may not kill plants; indeed, they may actually favor the growth of what we call "acid-loving plants." If we see huckleberry, sweet fern, wintergreen, and laurel growing in the woods, we know that the land is sour. If our fields produce daisies, goldenrod, running blackberries, and sorel, we know that the soil lacks lime or is sour. We know, as practical agriculturists, that alfalfa will tolerate no acid, red clover very little, alsike more, and cowpeas a great deal. Soy beans need more lime than cowpeas, and timothy more than redtop. Cantaloupes thrive with lime, but

watermelons do not. Beets, spinach, and lettuce are more sensitive to lime than are other garden vegetables. The amount of the element calcium in a plant is not a measure of the need of that plant for lime. Certain plants, such as beets, must have the soil in a definite condition in order to grow, though they do not use any more lime than other plants which grow with less.

An acre of potatoes uses more lime than an acre of wheat; but we seldom put lime directly on potatoes, because a small amount of free acid does not check their growth. On the other hand, a little acid seems to improve the quality and keeps them free of scab, the fungus of which does not thrive in an acid soil. This brings the potato grower face to face with a most difficult chemical problem; for if by keeping his field acid, in order to raise his crop free from potato scab, he brings the lime supply too low, he is unable to raise any leguminous crops, but must buy all of his nitrogen, which is very expensive. The solution of the problem is to apply moderate amounts of lime and then plow large crops of green manure into the soil, with which the lime will combine as humate of lime and be available to the potato as a plant food without entirely neutralizing the soil. If no lime is used, the yield is reduced; and, if the potato grower fails to keep up the soil acidity with vegetable acids, the quality of his potatoes will deteriorate.

If the condition of the soil is solved in this way, certain legumes such as cowpeas will thrive, or, if the territory is too far north for them, alsike clover, and winter vetch will supply the needed nitrogen, and reduce the cost of production.

A large grower of cabbage told me that if he used potash as a fertilizer on his beds of seedlings, it caused them to turn yellow and remain undersized. This was peculiar, in as much as cabbage uses considerable potash. When I investigated, I found the cause a simple chemical one and easy of solution. The soil was already as sour as cabbage could stand and thrive. The potash was applied as a muriate of potash ($KCl$), of which the potassium was used or fixed by the soil, leaving the chlorine to become free hydrochloric acid ($HCl$) which made the soil too sour for a young cabbage to grow in. The solution of the problem was to add the necessary potash either in the form of barnyard manure or else in the form of carbonate of potash ($K_2CO_3$) which does not increase the acidity of the soil. The successful tobacco grower often burns brush over his seedbeds because the ashes contain potash as a carbonate, which decreases the acidity of his soil. More than a slight acidity of the soil is a brake on progress. It is a friction which must be steadily overcome before progress can be made.

**Too much aluminum hurtful.** A condition which is becoming common in regions of little lime is that of having too much of the element aluminum in the soil solution. Aluminum forms some 10 per cent of the earth's crust, but has no place in the plant. Plants do not thrive in the presence of soluble forms of it, such as alum, but differ in their susceptibility. Sour soils seem to dissolve the alumina which, however, is thrown out of solution by hydrated lime. This condition is becoming prevalent in many of the soils of eastern United States, where the soil has long been used for cultivated crops, and where the use of much potash has exhausted the lime.

Plants have considerable ability to choose their food from the soil, but their composition is, to some extent, due to their food. Rich food makes rich plants. The bluegrass of southwestern Virginia fattens steers to a point where they are ready for export, but on less-favored soils the grass is less nutritious. The addition of nitrogen to the soil improves, in many cases, the quality of the crops as much as it increases the quantity.

## The Chemistry of Animals

The chemistry of animal life is as different from that of plants as the chemistry of plants is from that of the rocks. It is true that we cannot duplicate the processes of nature and create food in the chemical laboratory; but we can control these processes by spraying, fertilization, shade, irrigation, and tillage. We cannot either create life or duplicate some of its processes; but we can, by proper knowledge of the laws of chemistry, accelerate the desirable changes, and retard the undesirable ones. In comparison with a plant, we find that the animal is a user of energy, while the plant is an accumulator of energy. The plant builds up complex compounds, and the animal uses them for food, and eliminates them as simple products such as carbonic acid and water.

**Animals simpler in composition than plants.** Animals are simpler in their composition than plants in the sense of containing less chemical elements, but

the compounds they form are more complex. Like plants, animals are composed mostly of carbon, hydrogen, oxygen, and nitrogen, with phosphorus, sulphur, and calcium all fulfilling important functions. Iron is found in the blood, and a small amount of chlorine, sodium, and potassium in the fluids of the body; but neither potash, magnesia, nor silica occurs in large amounts. From a chemical standpoint, the most important change going on in the body is that of oxidation, or the burning up of the sugar of the body, thus setting free energy and heat. There are two great uses for food in the body: first, the building up of body tissue such as blood, nerves, muscle, etc.; and, second, the supplying of fuel for heat and motion. By far the largest part of the food of a mature man or animal is used in the second way. It never becomes a part of the real body any more than the coal in the fire box is a part of the machinery of the engine. When food is taken into the stomach and digested, the changes are mostly those of solution, so that the foods in the stomach may be taken to the liver for distribution. Much of the food we eat is starch, which is not soluble, therefore it must be changed to a soluble compound. This is done by the same method which the plant employs after the starch has been formed in the leaf. There are in the saliva and other digestive juices, certain substances called enzymes, which have the power to change many hundred times their weight of starch to sugar without the enzyme itself being changed or used up. The change from starch to sugar is only a slight one, consisting of the addition of a molecule of water to the 5 molecules already in combination with the 6 atoms of carbon found in each molecule of either starch or sugar. The sugar in liver is called "glycogen," or animal sugar, and is ready to be used by the body the for fuel. This glycogen is always found in the blood of a normal animal, and seems to be taken up by the hungry cells just as the live cells of plant roots take their nourishment from the soil solution.

**Muscle cells.** The cells of the muscles also need oxygen. When we breathe into our lungs a mixture of molecules of oxygen and nitrogen, the nitrogen leaves the lungs in the same condition in which it entered; but the oxygen passes through the thin walls of the lungs, and is carried away by the tiny red corpuscles of the blood on the other side. It would not be amiss to think of the red corpuscles as boats which carry the cargoes of oxygen to the muscle cells, where they are used to produce energy. We do not know how the power is produced; but we do know that sugar goes into the muscle, oxygen is absorbed, and carbon dioxide is given off just in proportion to the amount of muscular energy produced. *The muscle cell is the original internal-combustion engine.* It is a surprise to many people to find that the muscle itself does not wear out perceptibly in work. When we feel tired, it is because the available glycogen is gone. Endurance is the ability to supply the fuel of the muscle as fast as it is used, and to give enough oxygen to provide the energy as fast as it is needed. Oxygen is, then, our most important food and the one about which we often care the least. When we feel chilly, it is possible to get warm by taking 25 deep breaths of pure air, which so increases the supply of oxygen in the blood and muscles that plenty of heat is produced. Heat is usually produced in the body as a sort of by-product of motion; but, if need arises, food can be burned for heat alone.

Animals, such as dairy cows, when fed full rations, can hardly be said to use a share of their food for heat, because the heat produced by eating, digestion, and secretion is enough. The largest butter records are generally made in the coldest weather when the cow is not made uncomfortable by the heat of her body. I have seen large records made when the stables were at a freezing temperature.

The changes in the nitrogenous, or proteid, foods are more complicated than those of the starches or sugar. We know that part of the food is used to repair the waste of cells and to keep up the supply of blood, and that another part is used to form the protein substances in milk, as casein or albumen; but we are sure that all that is used in the body will be broken down and thrown off from the body by the kidneys as urea and uric acid or some similar product. The urine of an animal contains all of the nitrogen that has been used by the body, or some 60 per cent of the total. The remaining 40 per cent, in the solid excrement, is not so valuable for fertilizer because it is less soluble. While many of the intermediate steps are unknown, we can come to this certain conclusion: The starch and sugar are eliminated from the body through the lungs as carbon dioxide and water, while the protein is broken down into urea and escapes by way of the kidneys.

**Why milk production decreases.** The mineral portion of the food is now attracting much attention. Just as carbon or hydrogen cannot be substituted for protein containing nitrogen, we know that nothing can take the place of iron or phosphorus or lime. Corn is an example of a grain with so little lime that young animals fed on it exclusively do not have strong bones. Alfalfa and wheat bran are well supplied with phosphates and lime. Recent studies have shown that cows which are big milkers give off more calcium and phosphorus than they can secure from their food. When the store in the body reaches a certain low point, nature puts the brakes on milk production, and, despite feed or care, the cow decreases her production until her outgo equals her income of these two substances which we have never before considered as important foods. Up to the present, no method has been devised to feed cows an excess of either of these elements. It seems probable that this is the explanation of cows doing badly after an exceptionally big year. Breeders know that a big milking cow often produces a small, weakling calf, the reason being that the cow has no reserve supply of the minerals so necessary in forming the tissues of the next generation.

**What chemistry has done for the dairy cow.** The knowledge of chemistry has done more for the dairy cow in 40 years than had unskilled effort in the preceding 200. The Babcock test, described elsewhere, showed us the composition of milk, and gave us a basis for the selection of the best animals for breeding. This test also gave us a basis on which to build, for the dairy cow, a ration suitable for the manufacturing of the digestible and concentrated dairy products so necessary to health and comfort. We know that we must give the cow as much of the element nitrogen as we expect to find in the casein of milk, in addition to what she must have to supply her own needs of life and reproduction. We know from chemistry that no other element can be substituted for nitrogen, which forms about one sixth of the food substance protein. Thus chemistry, in the hands of practical men, has given us the balanced ration for animals and man, as well as the complete fertilizer for plants.

In addition to the principal foods, such as starch, protein, sugar, fiber, and minerals, there seem to be certain substances, called "vitamines," which are necessary in animal nutrition. These widely scattered and often complex substances are more frequently needed by young animals than by those of greater maturity.

Pigs fed on corn alone, or with mineral phosphates and lime added, were unable to grow, though kept for several years. Adding a very small portion of dried skimmilk produced a steady growth, as did a number of other substances. This does not mean that corn is not a good feed for pigs, but that a mixed ration is necessary. Young rats (chosen for experiment because they mature quickly) were not able to grow at all unless fed on milk fat or fat from the yolk of egg. No other fat could replace this until the animal had passed a certain stage of development.

Other animals require peculiar food, as the laying hen, which must have a large amount of carbonate of lime, in order to make shells for the eggs. If this is not supplied, the hen develops an acute and abnormal appetite which leads her to eat her own eggs or to pull feathers from other fowls.

**Disease due to improper food.** A knowledge of the chemistry of farm animals has shown us that the so-called disease of "hollow horn" is really hollow stomach, or often a real protein starvation. This may be prevented and cured by the direct and simple method of feeding protein, starch, and fats in proper proportion and amount to supply the imperative needs of the animal's body.

**Effect of lime and phosphorus.** Certain regions of the world have long been celebrated for the domestic animals they produce and their strong and vigorous men and women. Among such we may recall the Vale of Cashmere, northwestern India, certain valleys in Arabia noted for fine horses, some of the counties of England, the islands of Jersey and Guernsey, remarkable for cattle; France, the home of the splendid Percheron horses, and the bluegrass region of Kentucky. In all of these places, separated in some cases by thousands of miles, under different governments, and with different market requirements, we find the one common fact that livestock seems to have a natural tendency to improve, while in other and less-known regions it shows a tendency to become poorer. This running-out tendency has long been recognized, and two thousand years ago the poet Virgil wrote:

Still will the seeds, tho' chosen with toilsome pains,
Degenerate, if man's industrious hand
Cull not each year the largest and the best.

When we investigate these favored regions, from which seem to come all of our improved races of livestock, we find that the cause of this improvement is chemical and that it is common to all the sections. The reason for this success is an abundance of both lime and phosphorus in the soil and plants in the one region and a deficiency of them in the other.

**Effects of ignorance of chemistry.** A good illustration of the effect of chemistry, or rather of the results of ignorance of it, came to the attention of the writer in 1915, when he was called on to visit and advise concerning an abandoned farm in southern New York, where there had been a great decrease in rural population and in production. In early days, soon after settlement, both hilltops and valleys were cultivated and gave good fields of all the staple farm crops, fruit, etc. Livestock flourished, and good farm practices were the rule. A reasonably dense population lived there in contentment and comfort. This soil was poor in lime, having become depleted by crops and by leaching away in the drainage water. As the lime decreased, the phosphorus was changed from phosphate of lime to unavailable phosphates of iron and aluminum.

As these changes occurred, the crops of clover, peas, and other legumes failed, and the hay produced was of inferior quality, while the grain was less in yield. As a result of the poorer quality hay and the reduced supply of grain feeds, the livestock ceased to grow well, and the making of dairy products, the chief source of income, declined. Less and poorer manure was made, and wheat was replaced by oats, and oats, in turn, by buckwheat. Less land was cultivated until there was not enough hay and grain to winter the cattle which could find summer pasture on the hill pastures. As these changes went on, fields and, finally, farms were abandoned, and the people found homes in new and richer soils, or, disgusted with the poverty of such declining agriculture, added their numbers to the increasing congestion of the city. Now the wild deer have paths over the tumbledown stone fences which once restrained the more profitable sheep and cattle. Now, too, the descendants of these people join in bread riots or write pathetic letters to the charitable associations, because their ancestors did not, and at the time could not, know that lime was lacking in their soil; that, with lime, phosphorus also was lacking, and that, with the aid of both, they could have grown legumes to furnish the nitrogen wherewith to make profitable crops and build up a permanent, successful agriculture.

Where there is plenty of forage of good quality, animals thrive and return a profit, and from the nitrogen-fed plants and animals comes a strong and permanent civilization. Neglect or willful ignorance of the knowledge which makes man the master of his environment results in just what we have had described above—a deserted countryside, with wild deer making new trails across the unused fields and obliterated roads, while crowded and helpless millions in the city cry vainly for the food that is not.

## The Chemistry of Some Common Things

With such an elementary knowledge of chemistry as has been outlined above, it is an easy and agreeable task to inquire into the chemistry of some of the common processes and substances used or met with in our daily life. Not only will such a study enable us to understand better what we see, but it will enable us to predict and counteract what will happen when we do certain things.

### The Testing of Milk

As nearly everyone is now familiar with the operation of the Babcock test for the fat in milk or cream, it is desirable to say a word or two as to its chemistry. The fat of milk rises as cream, because it is lighter than the milk. A quart of cream weighs less than a quart of milk; and the richer the cream, the lighter its weight. If cream all rose quickly and was of equal richness, no other test would be necessary than to observe the thickness of the layer of cream. Cream, however, does not rise quickly or completely, because it is only a very little lighter than the milk and because the milk is sticky and retards the motions of the particle of fat, as seaweed impedes a swimmer.

In order to overcome this, we add sulphuric acid to the milk and accomplish two things. First, we make the milk much heavier, so that the fat has more reason to float. This is just as eggs will float in brine, but not in water, because the brine is heavier. Second, the acid dissolves all of the milk except the fat, and removes the obstacle of stickiness. The lime in the milk forms a sulphate of lime, which is found in the bottom of the bottle, indicating something of the bone-making value of milk. The sugar gives up a part of its water to the acid, leaving some charcoal in the liquid, which darkens it. If both milk

and acid are warm, this happens to a great extent, and the test is obscured by the mass of charcoal in the neck of the bottle. Acids do not greatly affect fats, and for this reason the butter fat rises undisturbed to the graduated part of the neck, where it can be measured. The heat of the liquids in the test bottle is due to the violent chemical actions, and is no more unusual than the heat of slaking lime or fermenting manure. Acid of unusual strength burns the milk and makes particles of charred sugar appear in the fat column, while weak acid fails to dissolve the curd properly, and leaves white flakes to obscure the results.

### Iron Rust

Nothing is more familiar to most people than iron rust, yet few understand it enough to control its effects. Common iron occurs in nature in combination with oxygen in the proportion of 2 atoms of iron to 3 of oxygen, or $Fe_2O_3$, which is familiar to us as iron ore, or rust, or Venetian-red paint. When this is mixed with carbon and heated, the carbon has the power to pull the oxygen away from the iron, allowing the iron to melt and run together. Thus the common metallic form is devoid of oxygen. Having thus been separated from oxygen, iron has a strong attraction, or chemical affinity, for it, which causes it always to tend to recombine with it or, as we say, to rust. Iron is seldom pure, but contains certain amounts of carbon, sulphur, or phosphorus, which seem to aid it in rusting. We often find in chemistry that the presence of some other element aids an action simply by being present; such an element we call a *catalytic* substance.

Pure iron and pure dry air do not combine at all, but impurities in the iron and moisture in the air seem to enable the air to get closely enough in contact with the iron to rust it. As soft wrought iron is the purest form, it lasts longest in exposed places, as fence wire or nails. Steel is not so durable, though its hardness and cheapness have made its use almost universal.

**Causes and preventives of rust.** The presence of salt in the rain or fog has a remarkable chemical effect in causing iron to rust. A mowing machine may rust more in a week's exposure to sea fog on Long Island than in a season in Colorado. The question of durable fence wire is one of chemistry. I have on my own farm in central New York some of the original barbed-wire fence which has been in use 40 years without rusting, because it was made of a pure, soft wrought iron. Covering the iron with paint or a coat of zinc will keep both oxygen and water off, but, unless the iron beneath is pure, the rust will form wherever a break occurs in the covering. When iron rusts, it gains rapidly in weight; and 7 pounds of nails, when fully rusted, will weigh 10 pounds.

The rusting of iron is not confined to our implements and tools, but occurs also in the soil where much iron is found. As this occurs, the oxygen is absorbed, the rust increases in weight and bulk, splitting open the rocks and setting free plant food. When the intelligent farmer finds streaks of iron rust in his subsoil, he knows that the rusting process is not complete, because there is not enough air. The lack of air will keep plants from sending their roots deeply for food and water. Iron rust is, therefore, a danger signal to the farmer, to be prevented in his implements by keeping oxygen away, and hastened in his soil by drainage and deep tillage. Iron combines with oxygen in two proportions, the combinations containing most oxygen being called "ferric compounds," and the others "ferrous compounds." Ferric compounds are generally red in color and insoluble, while the ferrous compounds are light in color and soluble. Soluble compounds of iron, as $FeSO_4$, are poisonous to plants, and are to be avoided, unless we want them to kill weeds. Thorough drainage aërates the soil and causes all of the iron to rust and so become insoluble and harmless.

### Lime-sulphur Spray

A great deal of high-grade lime is used by progressive farmers in making the various lime-sulphur sprays which are now so largely used on fruit trees, but not on potatoes. Sulphur has a peculiar power over fungous diseases; but it is hard to use when dry, as it is easily blown off by the wind. Lime forms several compounds called "sulphids," containing different amounts of sulphur, and a sulphate which has already been discussed in its relation to manure (p. 371). Sulphur has several valences, or combining powers, which enable it to form a number of sulphids, as $Ca_2S$, $CaS$, $CaS_2$, etc., according to the temperature, length of cooking, etc. Self-boiled lime sulphur, made by the heat of the slaking lime, contains different compounds of calcium and sulphur than that which is boiled for several hours. As it is less soluble, it is used on sensitive trees, as the peach, while the boiled lime sulphur is used on apple trees. After the lime sulphur is applied, the lime combines with the air and water, forming a carbonate, while the sulphur is set free as an element in particles too small to see. Thus $2CaS+O_2+2CO_2$ becomes $2CaCO_3+2S$.

The sulphur in this extremely fine state seems to be the substance that controls scale and blight; but in order to secure the minute division, we must utilize our knowledge of the chemistry of lime and so accomplish the solution of the sulphur and leave to the air the task of restoring it to the necessary condition. The white, limelike whitewash, which appears a few days after a winter spray is applied, has another effect in that it reflects the light and heat which would be absorbed by

the dark twigs, and by delaying blossoming a few days, often enables the trees to escape a late frost. The purest grade of high-calcium lime, almost free of magnesium, is none too good for making the lime-sulphur spray.

**Bordeaux mixture.** Bordeaux mixture is another and, perhaps, even more important spray, since it is used for fruit, potatoes, and cucumbers, and is the only spray which controls several plant diseases. Copper sulphate, or blue vitriol, is the essential part of this spray, just as the sulphur is in the lime-sulphur spray, the rôle of the lime being to prevent the sulphuric acid doing more harm than the copper does good. When copper sulphate is dissolved in water, the molecule $CuSO_4$ seems to separate into two parts—copper and the sulphate radical $SO_4$. If you put a bright knife blade in the solution, you will find a plating of copper over it in a few minutes. The $SO_4$ part combines with the water to form sulphuric acid, as can be shown by the fact that it will soon cut a hole through a metal pail and will turn blue litmus paper red. Our purpose in making this spray is to leave the particles of copper free, but so to combine the sulphuric acid that it will be harmless. Several substances will do this, but lime is cheapest and best, the action being: $Ca(OH)_2 + H_2SO_4$ becomes $2H_2O + CaSO_4$, which is insoluble and therefore harmless. When dilute solution of lime and bluestone are mixed, the particles of $CaSO_4$ are so small that they do not sink, but float, as dust does in still air. When concentrated solutions of lime and copper sulphate are mixed, curdling often results, and the large particles sink, making the last part of the spray quite different from the first.

We often hear that Bordeaux mixture must be freshly made. The reason for this is an obvious one to a person who has followed the foregoing explanation.

Not all of the copper sulphate molecules separate at first into copper and sulphuric acid. When a certain number have done so, the solution is as full as it can be of these divorced halves of molecules. After lime has taken some of the $SO_4$ out of the solution, other molecules separate, making the chemical change a continuous one for many hours. So it may (and frequently does) happen that a perfectly good Bordeaux mixture is left overnight and the following day finds that all of the available lime has been used and there is so much acid present that the plants are killed as by fire. On this account the lime and copper sulphate should be kept separate until wanted and then the part left should be dumped out at night.

There is a test for the condition of Bordeaux so certain that it should always be applied. Potassium ferrocyanide is a soluble yellow salt, often called "yellow prussiate of potash," which is almost colorless when poured into good neutral Bordeaux; but, if the lime has not combined with all of the $SO_4$, it makes a black, inklike streak.

A man who applies Bordeaux mixture without this simple, accurate test is as heedless as the man who leaves his barns uninsured. A half-ounce of the yellow crystals in a half-pint of water (which should be labeled "Poison") will make many tests.

A special Bordeaux mixture is used by many of the pickle growers of central Long Island, who put a pint of strong ammonia to a barrel of spray. The effect, which is good, seems to be due to the action of the ammonia in making the liquid spread out and wet the leaves completely, instead of drawing up into drops like dew on the grass or water on a dusty surface.

**Insect poisons.** Many of the insect poisons which are mixed with Bordeaux or lime sulphur are compounds which contain arsenic. Soluble compounds of arsenic are as deadly to plants as to animal life, but the insoluble compounds dissolve in the stomachs of insects. Arsenic, like phosphorus, forms acids, which combine with metals to form salts, most of which are insoluble. Paris green contains copper, but has lost favor by having some soluble arsenic, which may burn plants. Arsenates of lead, calcium, and zinc are all insoluble and safe to use. The free lime in the spray serves to keep the arsenic safe by combining with any soluble arsenic and making arsenate of lime, which is insoluble.

## The Chemistry of Cider and Vinegar

In the section on "The Chemistry of Plants" it is explained how the plant makes starch and sugar out of water, carbon dioxide gas, and sunlight. The chemistry of fermentation begins with these products and ends where the making of the starch began. This branch of the science belongs to what is known as *biochemistry*, because it relates to the activity of microörganisms, as yeasts and bacteria.

A neighbor of mine who was arrested for selling hard cider made his plea to the judge that the cider contained no alcohol for, said he, "I made that cider myself and have always kept it locked up, and *I never put any alcohol in it.*"

Other equally ignorant, if more virtuous, friends have refused to eat pickles that were made with vinegar obtained from hard cider.

On and about apples are thousands of tiny yeast plants, some of which find their way into the cider, where they grow by breaking up the molecules of sugar and taking some energy from them. One molecule of sugar becomes 2 molecules of alcohol and 2 of carbon dioxide. The change is

$$\underset{\text{sugar}}{C_6H_{12}O_6} \underset{\text{becomes}}{=} \underset{\text{alcohol}}{2C_2H_5OH} \underset{\text{and}}{+} \underset{\text{carbon dioxide gas.}}{2CO_2}$$

The sparkle in fermenting cider is due to dissolved gases. When cider kept in a warm place stops frothing, it means that the sugar has become alcohol; the more sugar, the more alcohol in the hard cider up to a point where the alcohol kills the yeast.

If we shut this cider up in a jug or bottle it will remain indefinitely as cider, or apple wine; but, if we expose it freely to the air, another change takes place, and oxygen is absorbed, making the alcohol into acetic acid; then the whole is called vinegar. The more fully we expose it to the air, the more rapid the formation of vinegar. Just as hard cider has little of sugar, so the vinegar contains no alcohol. The chemical change is

$$\begin{array}{ccccc} C_2H_5OH+O_2 & = & C_2H_4O_2 & + & H_2O \\ \text{alcohol } \textit{and} & \textit{become} & \text{acetic} & \textit{and} & \text{water} \\ \text{oxygen} & & \text{acid} & & \end{array}$$

The process is due to a bacterium which produces a slime called "mother of vinegar." When vinegar stands exposed to the air, it takes up 2 molecules of air and goes back to carbon dioxide and water, thus: $C_2H_4O_2+2O_2$ becomes $2CO_2+2H_2O$ and completes the cycle that began when a green leaf took up carbon dioxide and water to make sugar, thus: $6CO_2+6H_2O$ becomes $CaH_{12}O_6+6O_2$. A study of this entire reaction will be a most amazing proof that nothing in nature is ever wasted, but that all the pieces and parts are used over and over again.

## Chemistry of Soaps and Sodas

Most people know that such a substance as sulphate of potash is made of a base (potash) and an acid (sulphuric), combined to make what we call a salt. But comparatively few people know that fats, also, are chemically salts, being composed of stearic or palmitic or other fatty acids and the base glycerin. When we make soap, we use a much stronger base than glycerin to replace it and form a new salt which we call a soap. Hard soaps are made with caustic soda, and soft soaps with caustic potash, the latter being the more soluble. Soap may be made with lime; but it is not soluble, and is only chemically, not practically, a soap. Hard water often contains lime, which curdles the soap, making an insoluble lime soap in the place of the soluble soda soap. Most soaps are boiled, after which salt is added, the object being to separate the soap from the water and glycerin; but some toilet soaps are made by a cold process which leaves in the glycerin. Floating soaps have air forced into them; while soft, rosin is sometimes added, to make a soap lather more freely and also to improve its cleansing power. Transparent soaps are made by dissolving the soap in alcohol which is later evaporated.

**Soda** is so much used that we seldom stop to consider what it is, what its effects are, or what residues it leaves in the body. Without going into the details of processes, it may be briefly stated that soda is made out of salt and limestone, the sodium coming from the salt and the "sizzle" from the lime carbonate.

Washing soda is simple sodium carbonate, or $Na_2CO_3$; but baking soda has a double portion of $CO_2$, and is given the composition $NaHCO_3$. If we put this in boiling water, 2 molecules unite, forming $Na_2CO_3+CO_2+H_2O$; but when an acid is added all of the carbon dioxide is given off, and the soda forms a salt of the acid. In cooking, the most common acid is sour milk, which contains a little less than 1 per cent of lactic acid, $HC_3H_5O_3$ (written that way because only 1 atom of it is replaceable by a base). The reaction is

$$\begin{array}{ccccccccc} HNaCO_3 & + & HC_3H_5O_3 & = & NaC_3H_5O_3 & + & H_2O & + & CO_2 \\ \text{soda} & \textit{and} & \text{lactic acid} & \textit{become} & \text{sodium lactate} & \textit{and} & \text{water} & \textit{and} & \text{carbon dioxide} \end{array}$$

The sodium lactate is harmless; the other part of the milk adds food value; and the carbon dioxide makes the food "light." Bicarbonate of potash was the old-fashioned saleratus, and was displaced by the better and cheaper cooking soda. The object in the use of soda is to balance the soda and acid so evenly that none of either will remain in the food. Many other organic acids are used in the place of sour milk, such as the acids of molasses, of fruits, and of vegetables.

**Baking powder.** By far the most common method of separating the carbon dioxide from soda is by mixing it dry with a substance which will react with it when wet. Such a mixture is called "baking powder."

There are three types of baking powder, which, in the order of their value, are:

(1) *Cream-of-tartar powder*, a dry, acid salt.

(2) *Phosphate baking powder*, in which we use a good quality of acid phosphate, such as is used in fertilizer.

(3) *The alum powders.*

When the first is used, sodium potassium tartrate or Rochelle salts is left; this is harmless as taken in food, but a mild purgative in large amounts. The phosphates left when the second is used are neither helpful nor harmful. It is believed that the continued use of alum in any form is bad for the system. For further details about baking powders and their uses, see page 186.

## CHAPTER 18

# Other Sciences in Farming

ALTHOUGH farming, as we have said, is based to a greater or less degree on all the sciences recognized by man, it is sufficient for our purposes to discuss in detail only those with which the farmer is brought most closely in touch. In this group, in addition to physics and chemistry (already discussed) we include botany, breeding, geology and arithmetic, the first three representing divisions of the larger science of biology, and the last covering a field which is usually considered as of interest only to students, mechanics and scientific workers. How vital each of these is to successful farm practice is suggested in the following pages.—EDITOR.

## BOTANY

*By* K. M. WIEGAND, *Professor of Botany, New York State College of Agriculture, who is a graduate of Cornell University, from which he also obtained his degree of Ph.D. For 12 years after graduation, he taught in the same institution; then for 7 years he was Assistant Professor of Botany at Wellesley College, whence he came to his present position which places him at the head of the Botany Department of the College. He has published many articles including several for the Cyclopedia of American Horticulture. His investigational and teaching work has been supplemented by botanical explorations in Newfoundland and other places nearer home.*

*Botany is, indeed, one of the foundation stones of agriculture. It requires a man who knows the science thoroughly to explain its scope and purpose in such limited space. In Professor Wiegand, we have a man who can do this, and, what is more, in such a way that the explanation is made plain to every reader.*—EDITOR.

**WHAT botany is.** Botany is the study of plants. It deals not only with those directly useful to man, but also with the great mass of wild plants making up the covering of the earth. This study of the vegetation of the earth is of direct importance to the farmer as it underlies the more modern and scientific point of view. To understand our crop plants, especially the newer introductions, we must be able to read about them accurately and intelligently. To understand the weed situation, and to identify the weeds, we must be able to use books designed for that purpose. In buying nursery stock of rarer fruits, and especially in purchasing ornamental shrubs, an ability to use catalogues is necessary; and the same is true in regard to the purchase of materials for the flower garden, the home, and the conservatory. Growers are finding it necessary constantly to write these catalogues in more scientific and technical language. An understanding of the classification and relationship of plants gives a better appreciation of the nature and qualities of related forms, and what to expect in their cultivation or eradication. An understanding of the various uses of the plant-parts to the plant, and the way in which the life processes are carried on, the source of plant foods, and the way in which these are taken into the plant is essential to the intelligent grower of

plants. The effect of limy and sour soils on crops is better understood, and may sometimes be predicted, if the relationships of the plant are known. The effect of wet and soggy soils, light and shade, competition with weed plants and other problems of this sort, become clearer if details have been looked into more closely, and the physiology is better known. Through the study of botany we come to know more accurately about the kinds of plants useful to man, and their products; where these plants are native; and the history of their use to man. The study of botany gives the farmer a broader and more intelligent background in his relation to plants. A knowledge of the kinds of plants and their relationships as well as the facts about them furnish a pleasure in themselves, and give a sympathy for things around one which is no small part of the enjoyment of life.

The study of plants may be divided into several rather distinct lines, as follows: the classification, identification, and naming of plants (Taxonomy); the parts of the plant (Morphology) and what they do (Physiology); the relation of plants to their surroundings (Ecology); the distribution of plants (Plant Geography), and the plants useful to man (Economic Botany). These may be considered in turn.

**Classification, identification and naming.** Plants are classified in order that they may be better understood. The number of plants in the world is almost beyond conception. Recent figures have placed this number as high as 140,000 for the higher plants alone, and there are probably 100,000 more among the mosses, mushrooms, seaweeds, and other lower forms, making fully 240,000 in all. Without some orderly method of arranging such a vast number of plants, there would be absolute confusion, for the mind cannot grasp so much detail unless it is carefully connected and coördinated. Classification is as necessary to the farmer as to the botanist, and should render his outlook on plants easier and better.

Like all human knowledge the classification in botany has gradually undergone change. Originally it consisted merely in arranging plants in groups according to similarity in a few features of structure or form, simply for convenience in thinking about so many forms. At that time it was thought that all plants were created as they are now. After the theory of descent came to be generally accepted, classifications were made over so as to show real **relationship.** Our modern systems are our best expression of what we so far know of the blood relationship within the plant kingdom. The old-fashioned classifications are called artificial systems, while the modern are termed natural systems.

**To use a key.** Not only does classification help one to grasp and comprehend the great vegetable wealth of the land, but it enables us to identify plants which are unknown to us. For this purpose a skeletonlike outline of the classification is made, called a key, through which one may trace, step by step, the unknown plant until its place in the classification is finally reached, and its name obtained. It is important that the farmer be familiar with the use of such a key that he may be able to

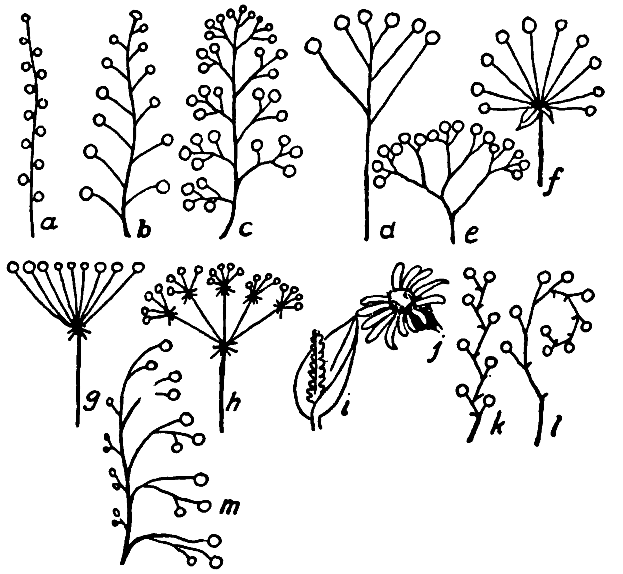



Fig. 328. Types of flower arrangement in diagrammatic form: *a* spike; *b* raceme; *c* compound raceme or panicle; *d* simple corymb; *e* compound corymb; *f* and *g* umbels; *h* compound umbel; *i* spadix; *j* head; *k* cyme; *l* scorpoid cyme; *m* secund cyme.

use our text-books for the identification of weeds and other plants. The following is an example of such a key:

A. Plants grasslike; flowers green.
  B. Flowers in an open loose cluster..........Oat
  B². Flowers in a close dense spike likecluster Wheat
A². Plants not grasslike; flowers showy.
  B. Flowers borne separately, either solitary or in a loose cluster.
    C. Floral parts 3 or 6 in each set ........Lily
    C². Floral parts 5 or many in each set.
      D. Pistils many in each flower..Strawberry
      D². Pistils 1 in each flower..........Plum
  B². Flowers minute, borne in dense heads which themselves look like flowers....Sunflower

Suppose the user has in hand a lily but does not know its name. He begins by reading each of the two sections marked A, and makes a decision as to whether his plant belongs to the first A or the second A. It is found to belong in the second division. The next step is to decide whether it belongs to the first or second B group into which the A is divided. This is done by carefully reading the statements under B and $B_2$ and comparing each with the plant. It obviously belongs to the first of the B groups, which is not further divided but leads to the name Lily.

The second B group is still further divided into groups, and if the plant in hand had been a plum it would have been necessary to go farther in subdivision until, in the last D group, we are led to the plum. All keys are constructed on this principle, and their use is the same. There is some variation in the manner of indicating the successive group. Some authors prefer letters, others signs for indicating the small groups. Another somewhat different way of writing the above, much used in classifying animals, also mosses, ferns, and the lower plants, is as follows:

1 Plants grasslike; flowers green..................2
  Plants not grasslike; flowers showy..............3
2 Flowers in an open loose cluster...............Oat
  Flowers in a close dense spikelike cluster...Wheat
3 Flowers borne separately, either solitary or in loose clusters......................................4
  Flowers minute, borne in dense heads which themselves look like flowers ...............Sunflower
4 Floral parts 3 or 6 in each set.................Lily
  Floral parts 5 or many in each set...............5
5 Pistils many in each flower.............Strawberry
  Pistils 1 in each flower.......................Plum

Success in the use of the key depends upon care and accuracy of judgment. Guesswork is a loser of time. It can be tolerated only when the particular feature of the plant mentioned in the key is not at hand, as for instance if the fruit is mentioned when we have only the flower. An attempt to obtain the fruit should then be made, but if this is impossible both sections of the key at this point should be tried in turn and the plant traced through each. A comparison of the two results will usually indicate which is right.

In the description of plants and in the keys mentioned above, one will find in most books a language in use which is not at once clear to the beginner. This is called the scientific language of botany.

Botanical language is an attempt to condense the descriptions and make them more accurate and definite. Frequently in ordinary language, because there is no exact word equivalent, a whole phrase would be necessary to express the idea that may be expressed by a single scientific word. By using these new terms each for an exact botanical idea, the description becomes more exact than would otherwise be possible. The botanical language at first seems very foreign and unnatural to the beginner, but it is really not difficult. A few terms looked up in the glossary (found in botanical books) from time to time will quickly enable one to read intelligently, and very soon this method of description will be preferred to the more cumbersome and inexact method otherwise necessary.

Plant names are of two sorts, the popular or so called common name and the scientific name. Common names are a part of the language of the people and their origin is in most cases lost in antiquity. Scientific names have been given by botanists and are constructed of Latin or Greek words. These names of the botanist seem very strange to the layman, and he is at first very loath to use them. The strangeness wears off, however, much sooner than one would expect. They are now being more and more generally used by laymen, and in trade, so that an understanding of them by the farmer is greatly to his advantage. In almost every seed and nursery catalogue of ornamental stock the botanical names and classification are used, and these are now frequently employed in bulletins and other reading matter for the farmer. This is not through a matter of choice primarily, but through necessity. Common names are very inexactly and loosely applied without any standardization. Frequently the same name has been applied to totally unrelated plants, as for instance in the case of the Snakeroot. This term has been applied to plants in the Buttercup, Milkwort, Birthwort, and several other families. The use of the word "snakeroot" therefore seems to indicate a relationship between these plants which does not exist, and is therefore very misleading. On the other hand, different names are often applied to the same plant, as in the case of the Shad bush. Along the coast, it is so called, but inland it is called June berry, and in the west Service berry. Common names are often very local, and not having been published with descriptions, it is impossible to make them definite, and often impossible to determine to what plant they belong. Many plants have no common name, as they were unknown to the general public. Frequent attempts have been made to construct a scientific nomenclature by definitely selecting or constructing a single English name for each plant. These have all proved impractical

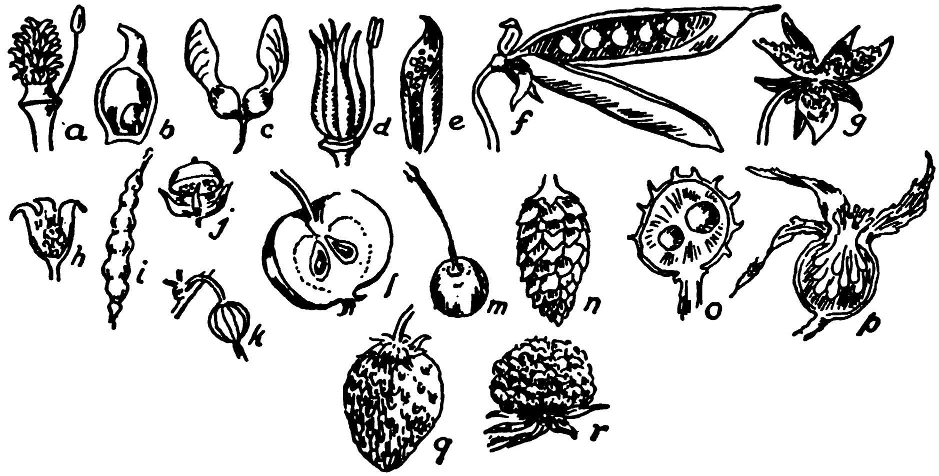



FIG. 329. Types of fruits: *a* achenes of butter cup; *b* single achene; *c* winged fruit (samara) of maple; *d* follicles of columbine; *e* single follicle; *f* pea pod; *g* violet capsule, half open; *h* section of another type of capsule; *i* pod or selique of mustard; j capsule or pyxis of four o'clock; *k* berry (gooseberry); *l* section of pome (apple); *m* drupe (cherry); *n* cone; *o* bur or husk containing two horse chestnuts; *p* hip (rose); *q* compound fruit (strawberry); *r* same (raspberry).

through the difficulty of distinguishing names thus constructed from those in general use. By employing a so-called dead language not now used by any people, this may be done. The Greek or Latin botanical name is, therefore, a necessity. After all, it is not difficult to become familiar with these names. They are no more foreign to our tongue than many which have recently come into general use. The words aeroplane, automobile, bicycle, and many others are just as much Latin as are the plant names, but we are now unconscious that they were derived from a foreign language.

The scientific name of every plant is composed of two words, as for instance, *Quercus alba*, the White oak. Of these the first is a noun, and answers to the surname among people. The second is an adjective indicating the particular kind, and corresponds to the given name. It is customary in Latin to write the adjective after the noun rather than before it as in English. Quercus signifies oak, and alba white, or white oak. *Quercus rubra* is red oak. *Quercus Michauxiana*, Michaux' oak, was named after an early botanical explorer in America, Andre Michaux. Botanical names are not used at random, but their use must follow definite rules or laws which constitute a *code of nomenclature*. The most important of these laws is that the very first name ever applied to the plant must be used, provided that it was properly published, and had not been used before for another plant. This is called the law of priority. It so happened that, in early times, when it was difficult to know what other men were doing, different botanists would give different names to the same plant. The earliest one only can be used; the others are called synonyms. In books we often find an abbreviation after the name. This indicates who gave that name to the plant; thus *Pinus Strobus L.* indicates that the great naturalist of the eighteenth century, Linnæus, first gave the name Pinus Strobus to the white pine.

Classification. Since the modern classification of plants is based upon relationship through descent, we begin our classification with the more primitive groups and progress toward the more recent. Usually the primitive are also more simple in structure, and the more recent are increasingly complex. This is, however, not always true, for sometimes history shows a degeneration in certain groups.

The largest groups into which the plant kingdom is divided are called *divisions*, such, for example, as the Algae, Fungi, and the higher or flowering plants. These are divided into *classes:* the classes into *orders*, the orders into *families*, and these in turn into *tribes*, then into *genera* and the genera into *species*. Oak is a *genus*, while white oak and red oak each constitute a *species*. Oaks, chestnuts, and beeches all belong to the same *family*. Ordinarily the species is the ultimate unit in classification, and represents a definite kind of plant. Each kind of plant is a species. Sometimes, however, in the case of species which are not always quite uniform in appearance, the species is divided into *varieties*, which represent well-marked strains of variation. The series of groups, therefore, in going from the broadest to the narrowest and smallest, is as follows: division, class, order, family, tribe, genus, species (variety). The classification of the plant kingdom into its larger groups is as follows:

DIVISION I Thallus plants undifferentiated into stem and leaf. (Thallophyta.)
- Class 1 Bacteria
- " 2 Slime molds
- " 3 Algae
- " 4 Fungi
- " 5 Lichens

DIVISION II Mosses and Liverworts (Bryophyta)

" III Ferns and Fern Allies (Pteridophyta)

" IV Seed Plants (Spermatophyta)

SUB-DIVISION I Pines and other cone bearers; seeds not in an ovary (Gymnospermae)

SUB-DIVISION II Flowering plants; seeds in a closed ovary (Angiospermae)
- Class 1 Plants with one seed leaf (Monocotyledones)
- " 2 Plants with two seed leaves (Dicotyledones)

**The Bacteria** constitute a group of very simple plants related to both the algae and the fungi. They are by many considered to be degenerate algae which have lost their green color and become parasitic, or live on dead matter. Bacteria are the smallest known organisms, consisting of extremely minute individual cells, or chains or plates of such cells. Under certain conditions, they reproduce by spores after the manner of algae, though their actual increase in number is by division of the cells. Bacteria are not dissimilar in form and structure, but in their effect upon their surroundings, they differ very widely. It is because of this that these minute organisms are of the greatest importance to other plants and animals. Most disease is due to them, also most decay. If it were not for bacteria and fungi, together the greatest scavengers of the earth, the earth's surface would soon become clogged with plant and animal remains. Bacteria in the soil render it fit for plant growth for to them the available nitrogen is due, and they also cause other important changes in the soil necessary to plants. The number of species is 1400 or 1500.

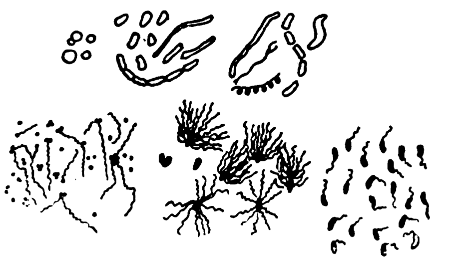


FIG. 330. Types of bacteria: *above*, the three main classes—round, rod-shaped and spiral; *below*, various forms equipped with *cilia* or hairlike projections which enable them to move.

**The Slime molds** (Myxomycetes) make up a group of low and very simple organisms of probably great antiquity, lying on the border line between plants and animals. Various kinds may be found in the woodlands in summer, where in the rainy season they are often abundant. Over 400 species are known. Reproduction is by means of single-celled spores, not seeds, which are blown about by the wind. On germination, a little motile cell is formed which swims around in dew and rain like many of the forms of lower animal life. Later these cells fuse together into a sheetlike mass of naked protoplasm, often several inches in width and frequently of brilliant color. This mass creeps up on to logs, stumps, or other elevated objects, where spores are again produced. In spore formation, the slime mold resembles a plant rather than an animal. One species of slime mold is of great economic importance, being the cause of the club root of cabbage. Unlike its relatives, this species has acquired the habit of living within the tissue of a higher plant, and is a true parasite.

The algae form another of the lower groups of plant life. They also do not produce seed, but simply spores. The algae, however, contain the green pigment chlorophyll, and in this respect are like the higher plants. The plant body is usually threadlike in the simpler forms, or is often in the form of single, minute, round, microscopic green cells which sometimes, because of their great number, give the appearance of green paint. In the more complex forms, the plant may be several inches or even many feet long, and branched. In the seaweeds which are marine algae the plant body is often very large, flat and ribbonlike or sheetlike, and variously forked. In many of the so-called "red seaweeds" the green color is disguised by a red pigment, which makes them objects of great beauty. There are probably 14,000 species or more of algae. Some kind or other may be found in almost every region of the earth. The green "paint" on the north side of damp tree trunks, the green scum on ponds (the duck weed is much coarser), and the pond silk or frog spittle are all algae. Algae are common in both fresh and salt waters and on wet rocks and stones. Because of the small size of the parts, a microscope is usually necessary to see them clearly. Algae are wonderfully beautiful as seen under the microscope, and very fascinating to one who is interested in the marvels of nature, not only because of their beauty, but because of the intricate methods of reproduction and the peculiar life histories. As compared with the fungi, however, they are of little economic importance to man. Irish moss used in cooking, is a seaweed. Various seaweeds called kelps are now a commercial source of potash, bromine and iodine. It is hoped to substitute the kelps for the waning saltpeter supply as a source of potash. Some

FIG. 331. Mushrooms, the fruiting bodies of a true fungus.

fresh water algae are a serious pest in water supplies as their growth in the reservoir gives a brackish taste which is unpleasant. Some prefer such odd places to live as sewers and hot springs.

The group of Fungi is a large and very important one, about 60,000 species being known. Fungi reproduce by spores and not by seeds. The manner of spore reproduction is very diverse in the different sub-classes. In the bread mold and blights the spores are borne in cases or sacs or free at the ends of the threadlike branches of the plant. In fruit mold, many mildews, and in the "cup fungi" which grow on logs, stumps and on the ground in woods, spores are also borne in tiny sacs each of which contains eight spores. In the rusts, as for instance the grain rust, spores are of several sorts but none is borne in sacs. In mushrooms, the spores are borne in groups of four on short pedicels which are thickly placed on the gill surfaces.

Fungi are very diverse in form. Many of the simpler forms consist of slender tubular filaments as fine as cobweb hairs, and with or without cross partitions in them. In others these simple or branched filaments are united in various ways to make a more complex body, as for instance the mushroom, which is made up in this way. Fungi do not contain the green pigment chlorophyll and are, therefore, unable to manufacture their own food, for which reason they depend upon other sources for their food. Fungi are therefore all either parasites or else they live on dead and decaying organic remains.

FIG. 332. A moss plant (enlarged)

Plants of this group are of great economic importance to man. They are the main cause of the decay of timber. Along with bacteria, they are the great scavengers. To them most of the important plant diseases are due. It is interesting, however, that very few, if any, animal diseases are produced by fungi, these being due mainly to bacteria. Mushrooms and some others are edible and an article of commerce. Fungi are exceedingly common everywhere. Those causing plant disease are often so small as not to be readily seen, but larger kinds such as the mushrooms or toadstools, and the woody shelf forms, are well-known objects in the forest.

Fungi are divided into the following large groups mainly based on their methods of spore production:

SUB-CLASS I. ALGAL FUNGI or tube fungi (Phycomycetes) with no cross walls in the filaments.

*Order 1.* EGG FUNGI (Oomycetes), with the sex organ differentiated into egg-cell and sperm sacs, as for instance downy mildew, potato blight, damping-off fungus, watermolds, etc. About 150 species are known.

*Order 2.* YOKE FUNGI (Zygomycetes), with the sex organs similar, as for example bread mold. There are about 190 species.

SUB-CLASS 2. THE TRUE FUNGI (Eumycetes), with cross walls in the filaments.

*Order 1.* SAC FUNGI (Ascomycetes), with one kind of spores borne in sacs, as for instance yeasts, truffles, black-knot, mildews, and fruit mold. There are fully 9,000 species, distributed in about 7 orders.

*Order 2.* BASIDIA FUNGI (Basidiomycetes), with spores in group of 4 at the ends of pedicels as, for instance, smuts, rusts, mushrooms and puff balls. There are about 18,000 to 20,000 species, classed in 4 or 5 orders.

Lichens are mostly gray, mosslike plants growing upon trees, rocks or upon the soil. They are not differentiated into stem and leaf but are upright and branched, flat and ribbonlike, or flat crustlike and closely adhering, to the object on which they grow. Lichens have the appearance of being real plants just the same as are mosses and ferns, but the wonderfully interesting discovery was made some years ago that they are really colonies of fungi and algae growing together, each necessary to the welfare of the other. These singular plants are found often in great abundance in forest, glen and shady roadsides or on the soil in sterile fields, and are very abundant northward. Many hundred species are known, but very few are useful to man. The Iceland moss, so called, is a lichen sometimes used in medicine.

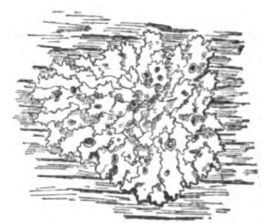


FIG. 333. A lichen on a piece of bark

Mosses and Liverworts are green plants standing closer in relationship to the higher plants than do the algae and fungi. The reproductive bodies, however, are spores and not seeds. There are definitely two stages in their life; one stage producing only sex organs and the other only spores. These two stages regularly alternate. The first stage consists of the moss plant itself, a slender stem provided with thin flat leaves; while the other stage consists of the spore-capsule and its stalks only. The moss capsule is quite complex in structure provided with a cap, a lid, and 1 or 2 rows of teeth around the mouth, which move back and forth with the varying dampness of the air. In this way the distribution of the spores is regulated.

Mosses occur in damp situations everywhere, but are especially abundant in cooler

and mountainous countries. They festoon the banks, fallen logs, and tree trunks in the deep forests or glens, with delicate green. Some are modified to grow in very dry situations, while the peat moss, Sphagnum, has the power to retain water so as to provide itself with a uniform supply. Peat moss occurs in enormous quantities in bogs, where it grows over the surface of the mud to a depth of many inches. Because of its water retaining powers, it is of economic importance in packing nursery stock, shipping live plants and cut flowers, and also to the florist in germinating seeds. In the Great War, it has become of much importance as a surgical dressing because of its absorptive and antiseptic properties. Other mosses are of little direct economic value. Some of the larger have been used for stuffing mattresses and pillows.

Liverworts are closely related to the mosses belonging as they do to the same division, and would not readily be distinguished from them. Many have a mosslike appearance while some are flat and ribbonlike and not differentiated into stem and leaves. These green ribbonlike forms may be readily found on damp rocks in glens, and on damp soil where fires have occurred.

The **Ferns**, like the mosses, have two stages in the life of each plant, one bearing sex organs and the other spores only. But here the conspicuous fern plant is the spore-bearing stage, while the moss plant bears the sex cells. The sexual stage of the fern is a small thin, green heart-shaped, flat body one eighth to one third inch in diameter, lying upon the ground in damp, shady places. Ferns were much more abundant in past geological time, as, for instance, when coal was being formed, and represent an old race which is gradually becoming extinct. They are now most abundant in damp woodlands, especially in humid and warm climates. The spores are borne in tiny cases bunched together in rust-colored groups usually on the underside of the leaves. Besides the true ferns, there are also other plants in this group, called fern allies, which have a less fernlike appearance. Among these are the horsetails, the clubmosses or ground pines, the selaginellas, the quill wort, water clover and others.

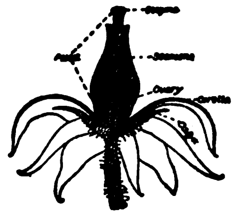


Fig. 335. Section of a flower showing essential floral parts.

Fig. 334. A fern showing rootstock or underground stem, and new and old leaves or fronds.

The so-called **Higher or Seed-bearing plants** constitute the largest group of the plant kingdom and are probably the most recent in origin. They, also, show an alternation of stages, though the structures involved have become so intricately involved that it is scarcely possible to make this alternation clear in the brief space at our disposal. A subdivision of this group is often called the "flowering plants" because here only do we find the structure ordinarily known as the flower. The flower is a much modified branch, the parts of which correspond to much modified leaves. The central organs or pistils bear the seeds in a closed pouch, and the seed is perhaps the most characteristic of the several peculiarities of the group. It consists of a young embryo plantlet which has developed to some extent, has become dormant, invested by protective coverings and supplied with food for recommencing growth. Just outside the pistils are the stamens which bear



Fig. 336. A, pine branch showing very young pistillate cones (*a*) at tip of shoot (*b*); pistillate cones one year old (*c*), and two years old (*e*), the latter opening and shedding seed; and a group of young staminate cones (*d*). B, ripe pistillate cone partly in section showing how the seeds lie unenclosed in the axils of the scales.

FIG. 337. Seeds of gymnosperms and angiosperms (see text): *a* scale of pine cone with two winged, unenclosed seeds; *b* hemlock cone; *c* scale from (b); *d* mustard pod; *e* follicles of monkshood; *f* section of apple. The last three show enclosed seeds.

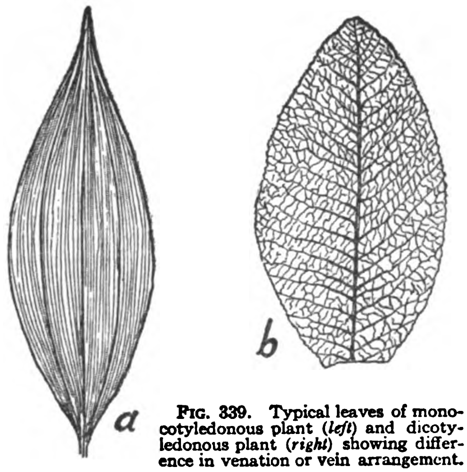


FIG. 339. Typical leaves of monocotyledonous plant (*left*) and dicotyledonous plant (*right*) showing difference in venation or vein arrangement.

pollen. In the pollen are found the sperm cells, one of which must unite with an egg cell in the young seed before an embryo may be formed. The plant seems to desire that the pollen should come from another plant, so insects or the wind must be used to transport the pollen. The outer portions of most flowers, the petals, are very showy to attract insects for this purpose. The outermost envelope of the flower, the calyx, is usually green, and serves to protect the flower while in the bud.

The seed plants with open seed organs (Gymnosperms) are the pines, spruces, hemlocks and other cone bearers of our northern forests. The greenhouse Cycas or "sago palm" also belongs to this group. These plants were much more abundant in past geologic times, and now form only a small part of the seed plant group.

The seed plants with closed seed vessels, ("flowering plants") are divided into two groups, partly on the basis of the number of seed leaves on the embryo and future seedling to which it gives rise. The *monocotyledons* have one cotyledon or seed leaf, the *dicotyledons* have two. The flowers of the monocotyledons usually have their parts in sets of threes, their leaves with longitudinally parallel veins, and the stem with scattered woody strands (as in corn stalk); while the floral parts in the dicotyledons are usually in fours or fives, the leaf veins form a network, and the woody strands are in a cylinder appearing as a ring when cut across. Among the monocotyledons, are such plants as grasses, oats, wheat, rice, corn, rushes, lilies, onions, asparagus, iris, and the orchids. Among the dicotyledons are all northern forest trees and shrubs, buckwheat, strawberry, blackberry, rose, apple, cherry, sunflower, daisy, dandelion, and very many other well-known plants. To seed plants we owe nearly all the green color of the landscape, and by far the greater number of useful plants belong to this group. Botany as it is usually studied is to a large extent a study of the flowering plants, partly because of their importance, and partly because a microscope is rarely needed in carrying it on.

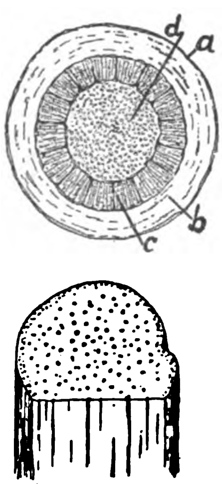


FIG. 338. Stems of a dicotyledonous plant (*above*) and a monocotyledonous plant (*below*). In the former: *a* epidermis or bark; *b* cortex; *c* vascular cylinder; *d* pith. In the latter note merely pith and scattered bundles showing as black lines and, in cross section, as black dots.

**Herbarium.** In the study of plants, a collection is often helpful. It is frequently desirable to preserve various plants of interest. They are best preserved in the dry state, for to keep them in liquid is generally too expensive and too bulky. Only delicate fruits, algae and fungi need to be placed in liquid. The collection of dried plants properly labeled and classified is called an *herbarium.* The plants are dried between blotters under pressure, and the blotters are frequently changed and dried to prevent mold and to preserve the green color. When dry, the specimens are glued to sheets of firm white paper of uniform size, all neatly labeled in the same corner with the name, kind of locality, place, date, and collector's name. These sheets may be filed under genera, families, etc., in specially constructed cases. A

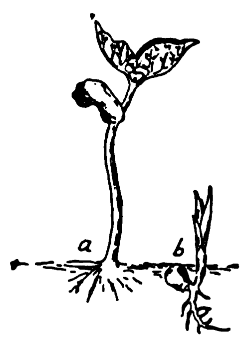


FIG. 340. Seedlings of bean (*a*) a dicotyledon, and of corn (*b*) a monocotyledon, showing the seed leaves held in the air by the first and underground by the second.

collection of this sort will be found not only useful for purposes of comparison and study, but also a source of pleasure in itself. It is a strong stimulus to one's interest in his or her surroundings.

**Morphology.** An important portion of the science of botany deals with the parts of plants and their uses. The study of the kinds and shapes of plants is called morphology, which means the study of form. The uses to which these parts are put by the plant is called physiology. Morphology is of two kinds: that which deals with the general external shape and configuration of plant parts, or *general morphology*, and that which deals with the internal makeup of the parts, or *anatomy*. All plants are made up of cells, and these are united into tissues of various kinds. The internal make-up of the higher plants is very intricate. Also the rôle which each structure plays in the life of the plant forms an extensive study. The farmer should know something about both the morphology and physiology of plants, as these are fundamental to an accurate knowledge of how crops grow and the way in which crops are influenced by varying conditions.

**Ecology.** Another phase of botany is called ecology or the study of the relation of plants to their surroundings; the effect of different kinds of soils, of varying quantities of water, of different degrees of shade, and of competition between plants. Ecology is of special value to the farmer, as it deals with most of the fundamental problems of the relation of crops to their surroundings.

**Plant geography** is the division of botany which deals with the distribution of plants over the earth. This is a large field of study and a very interesting one. The plants of the different countries differ widely depending upon climate and the distance of one country from another. A careful study of plant geography throws much light upon the agricultural possibilities of the various countries. One may often judge more accurately how well suited a region is for a certain crop by noting the natural vegetation than by any other means.

**Uses of plants.** Another phase of botany dealing with the uses of plants to man is *economic botany*. Plants furnishing useful products are studied from the standpoint of relationship, classification, structure, the method of preparation of the product, and its manner of use. To pursue this study successfully, one should be within reach of a good museum of economic products.

# BREEDING

*By* EUGENE DAVENPORT, *Dean of the College of Agriculture and Director of the Experiment Station of the University of Illinois. After graduating from the Michigan Agricultural College, he became, first, Assistant Botanist of its Experiment Station, and later, Professor of Practical Agriculture and Farm Superintendent of that institution. For 2 years before assuming his present duties, he was president of the Collegio Agronomica, of Sao Paulo, Brazil. Although this wide experience has kept him in touch with all phases of agriculture, his special line of investigation has been the science of breeding, in which he holds a place among the very foremost authorities. While the subject has two sides—one the field of the scientist, the other that of the farmer—it is essential that the specialist in each line know something about the other. Dean Davenport tells the farmer what the science of breeding is, so that he can do more with it as an art and a practical business.*—EDITOR.

EVERY animal of the barnyard and every crop of the field, the orchard, and the garden, is a descendant, either direct or indirect, of some wild species that attracted the attention of primitive man as affording something of value in the way of food, clothing, or service. The dog for the hunt, the horse as a beast of burden, the sheep for its wool, the pig for its meat, and cattle for their milk, meat and hides, were among the earlier domesticated animals. Then came the grains, the grasses, the fruits, and last of all, the vegetables. During the long process of domestication all these species have been greatly "improved"; that is, their useful characters have been developed and strengthened, while their objectionable or less desirable traits and qualities have been more or less modified, and in some instances entirely "bred out" so far at least as practical considerations are concerned. For example, the horse is more swift and

less timid in domestication than in the wild state. Cows give more milk and milk of better flavor than do wild species. The beef breeds have thicker meat with less development of the coarser parts. The fiber of wool is both longer and finer, with a smaller admixture of hair. The grains "stool" better and yield more. Fruits are larger, sweeter, and of finer quality, with a reduction of unpleasant flavors, and of spines on wood or fruit. Vegetables are larger, of finer texture, and with a greater content of starch, or sugar,—as in the potato and the beet. Some of these changes are of long standing and others,—like those in the grape, the strawberry, and the tomato,—have come about within the lifetime of men yet living.

The success of the breeder lies in the fact that no two animals or plants are precisely alike, and that these slight differences are for the most part transmissible. By breeding from "the best," therefore, the offspring is nearer what is wanted than would have been the case had the blood lines been left to accident. Successful breeding is both an art and a science—an art, because it requires the ability to note slight differences; a science, because it requires a knowledge of the relations between characters and their behavior in descent.

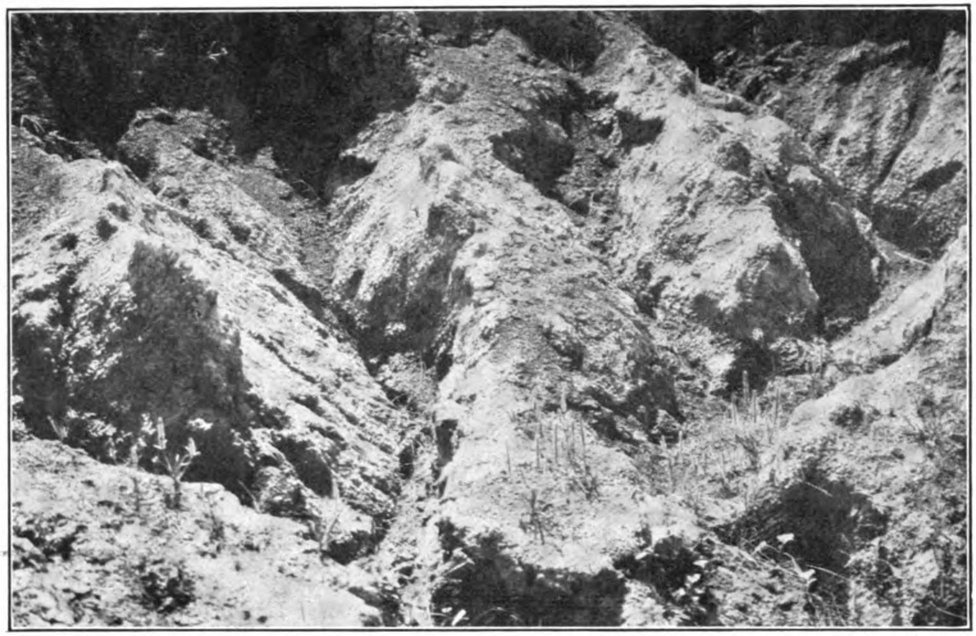
**DEFINING THE OBJECTIVE.** No two men would agree as to what is "best" for any particular purpose. For that reason alone no two breeders secure the same results, and it is always easy to distinguish one man's breeding from that of another even within the same breed. To decide what constitutes the "best" is, therefore, the first step in successful breeding. Of course what is best for one man or for one purpose is not necessarily best for another, but if the individual breeder is to succeed, he must first, as in building a house, decide definitely what he needs for his purpose, and then adhere to the plan, for if the principle of selection is to change with every generation, the herd cannot be uniform.

The second most important step in making a plan for successful breeding is to make the plan simple, involving as few "points" as possible. For example, if all that is required of the cow is that she shall give a heavy yield of milk, it will be very much easier to succeed than if she must also be of a particular color and bear a horn of specified size and shape. It is sufficiently difficult to find enough cows with good digestion, good health, and active mammary glands,—all of which are necessary to good milking qualities,—and every time an additional specification is attached, the problem of selection rapidly becomes complicated and correspondingly more difficult.

This fact rules out mere "fancy points" except in cases—and they are frequent—in which the breeder depends upon popular favor for his sales. In such instances, he must have regard to fashion or be driven out of business, for unfortunately, except in racing horses, there is fashion in breeding as there is in dress.

**WHAT IS A BREED?** When a strain has been selected for the same points and for a good many generations, it comes to be called a *breed*, and is spoken of as "pure," especially if the owners have established a herd book in which the record of all animals of this breeding can be traced. The term "purebred" is not strictly proper because all breeds "run into the woods" sometime; that is, they all trace back to unpedigreed stock where breeding is unknown, and beyond that to the wild. The term as used, however, is understood merely to denote that the "purebred" individual has no recent admixture of outside blood, and that since the improvement began he has been bred entirely within the established lines of the breed. Thus we speak of "pure" Percherons, Shorthorns, Jerseys, Berkshires, etc. The term "thoroughbred" should never be used except to denote the English running horse.

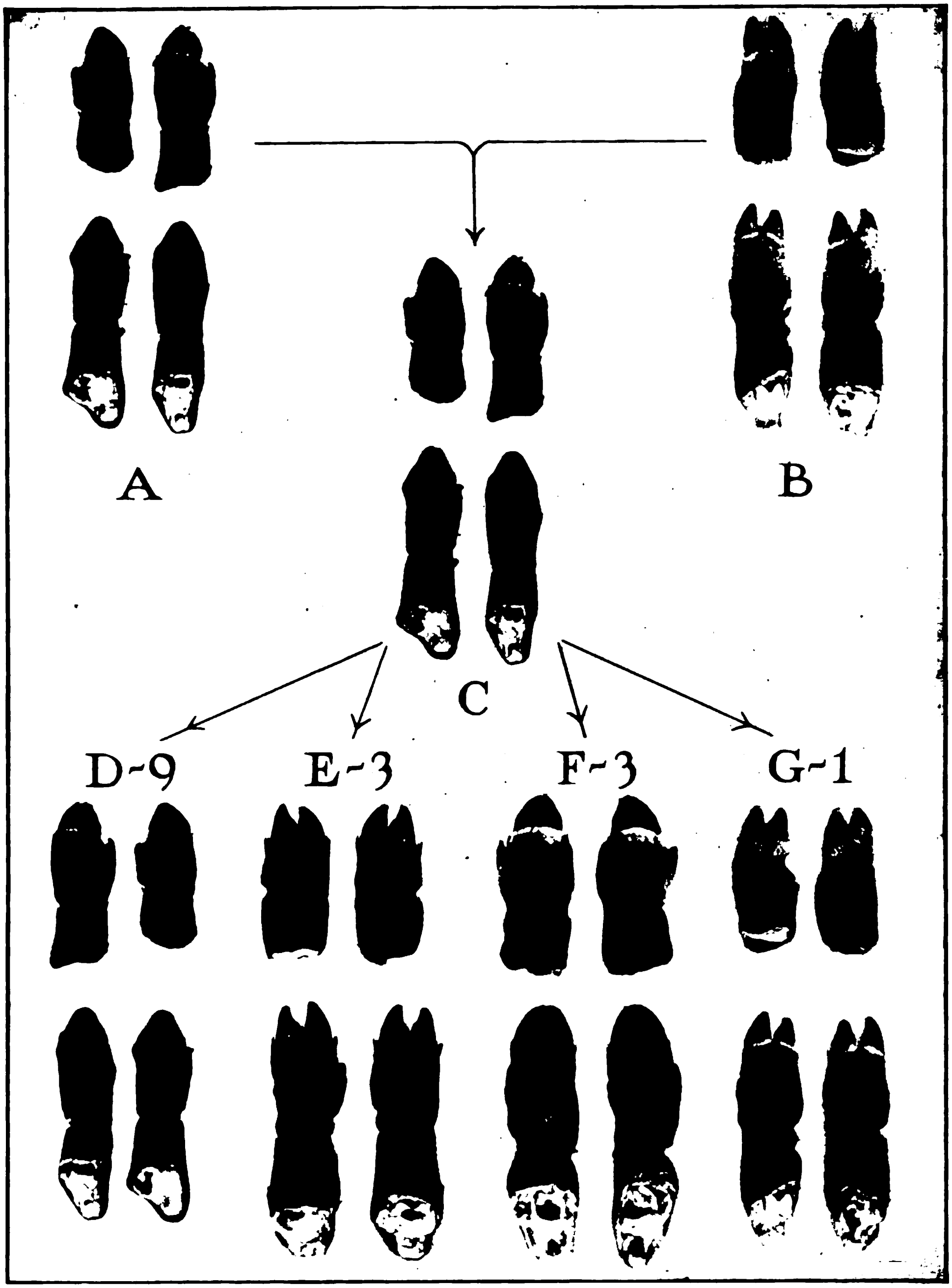
**Correlated qualities.** By their behavior in descent, we see that some characters are quite independent of all entanglements, while others appear to be "correlated" or bound together by bonds that are practically indissoluble. Correlations between acceptable characters are, of course, in every way desirable, for they then go "*en bloc*," but oftentimes a very objectionable quality seems inevitably linked with the very purpose of the breed. For example, a certain and considerable amount of oil is secreted by the skin of the sheep, and this amount increases with the fineness of the fiber. Sheepmen naturally desire that their feed should go to the production of wool rather than of "grease" which has little or no value; but thus far they have been unable to breed a fine-wooled sheep without considerable grease. Whether accidental or otherwise, most breeds have certain undesirable qualities that seem to be so associated with the general makeup as to be exceedingly difficult to eliminate. For example, one breed of pigs has poor hams with perfect shoulders, while the reverse is true of another breed. In this way one or more "yellow streaks" run through the physical or mental makeup of most breeds, and to get rid of these without



Destructive soil erosion is not an unhappy, unreasonable freak of Nature, but the inevitable result of physical laws acting where ignorance or carelessness has paved the way

Chemistry has shown us how to treat seeds so as to destroy bacteria that produce disease, and also how to treat them so as to multiply others that increase the supply of nitrogen in both soil and plant

THE SCIENCES ARE NO LONGER MYSTERIES TO BE STUDIED SOLELY FROM BOOKS WITHIN BRICK WALLS. THEY ARE PART OF THE STOCK-IN-TRADE OF EVERY SUCCESSFUL FARMER




AN ILLUSTRATION OF SOME OF THE PRINCIPLES OF BREEDING AS APPLIED TO THE TRANSMISSION OF CHARACTERS IN FARM ANIMALS. A AND B ARE THE ORIGINAL PARENTS; C THE FIRST GENERATION FROM THE CROSS; AND D, E, F AND G THE PROGENY MAKING UP THE THIRD GENERATION. SEE PAGE 400 FOR COMPLETE EXPLANATION

disturbing the other qualities, is the constant aim of the professional breeder.

**Grading** is the practice of putting pedigreed sires at the head of unpedigreed herds. When this is done, the first generation of offspring will possess one-half the blood of the sire and will be called "half-bloods." Thus by buying a single animal the owner gets, the first year, one half the supposed benefits of the pure-bred so far at least as utility is concerned; that is, if the animals represented by the sire are better feeders or better milkers, or bear better wool than the unimproved herd or flock of the farmer, one half of this advantage would be secured at once and by the purchase of only one animal.

If these half-bloods should be bred together, they would manifestly remain half-bloods, and all improvement would be at an end except as the owner should practise selection. Some selection is always needed, but the stockman can do far better than to stop at the first step, for if these half-bloods in their turn be bred to a full-blooded sire, their progeny will be three-quarter bloods; the next generation, seven-eighths, and so on until, in a few generations, the fraction of "unimproved" blood remaining is negligible. So by grading does the farmer quickly and cheaply secure nearly all the advantages of the pure-bred so far as performance goes, and that too by buying only one animal at a time. Indeed, if he has bred in rather large numbers and practised rigorous selection, he may produce a herd of grades that are actually better performers than are most of the full-bloods, and it is the performance test that indicates the commercial value of livestock.

Manifestly there will always be a remaining fraction of unimproved blood in a herd produced by grading or "grading up" as the phrase goes. For this reason the grade is never eligible for registry, and should never be used for breeding except upon inferior herds. It is a general principle that the sire should, if possible, come out of a breed greatly superior to the one he is called upon to head. So shall he do much good and prove a wise investment.

**Crossing**, or the mixing of two distinct breeds, is the abiding temptation of the amateur, as it is the favorite theme of the uninformed writer, who assumes that the results of the labors of a man like Burbank are the outcome of far-seeing combinations of "blood lines," whereas they are mostly due to the selection of those fortuitous combinations—like albino deer, white blackberries, spineless cacti, etc.—that arise in nature where animals and plants are breeding together in large numbers. These "mutations" are constantly occurring both in nature and in the breeding yards and fields, and it is a fine exercise of the breeder's art to detect and bring out those that possess real value. However, that is quite independent from the business of producing these strains artificially. Crossing aims at the production of new strains, not by gradual improvement of an existing breed through selection, but by actually uniting two distinct breeds in the hope of securing something better than either by combining the good qualities of both, as for example, attempting to produce a cow that will give as rich milk as the Jersey and as much of it as the Holstein-Friesian.

**PRACTICAL DIFFICULTIES.** As a matter of fact, the problem of improvement is not so simple as it might seem. There are several reasons why so desirable an end cannot be so easily accomplished as is popularly supposed. In the first place, to expect a cow to give as rich milk as does the Jersey and as much of it as does the Holstein-Friesian, is to ask her to do double duty. To expect a horse to go as fast as a racer and at the same time to pull as much as a Percheron, is to attempt to bring together two incompatible qualities, —namely, high speed and extreme weight. Secondly, every breed has remaining in its makeup a number of more or less undesirable characters that the breeders have never been able wholly to eliminate, but only by the most vigorous selection to keep down, or "latent" as the phrase goes. So thoroughly are some of these latent characters suppressed that their presence would never be suspected. For an extreme example: Most English breeds run back to wild white cattle with red ears. While such specimens almost never occur in registered herds, crossing is likely to bring out even these "long-lost characters"—not lost in truth, but well suppressed until in the new shuffle they come to the surface and, to the

FIG. 341. Practical plant breeding in the field: cross fertilizing wheat in experiments aiming at the production of better varieties.

surprise of the owner, the result of the "cross" is a nondescript thing that nobody wants. Again, characters frequently refuse to blend, and as a consequence all sorts of unexpected things may happen in crossing. For example, the writer once saw a span of horses bred from a Clydesdale stallion and a matched span of trotting mares. Both were of good size but the front end of one and the hind quarters of the other were distinctly Clydesdale while the remaining parts were trotter. The span looked as if a Clydesdale and a trotter had in some way been divided at the middle and the ends mismatched.

**LAW OF RESULTS.** In general, if large and small breeds be crossed with a view to increasing the size of the smaller, the first result may be and often is a medium that is satisfactory. But when these crossed forms are bred together with a view to increasing numbers and to fixing the medium size, the stockman is surprised to find that the progeny breaks up into three forms—one large like the one parent, another that is small like the other parent, and a third that remains medium. If now he discards the large and the small and attempts to fix the medium size by breeding only mediums, he finds again the same phenomena, for this generation, like all others produced from the crossed stock, will be of the general formula,—1 large, 2 medium, 1 small.

Examples might be multiplied indefinitely to show that characters do not always blend in descent, but that often each tends strongly to preserve its identity so that descent is "bit by bit." Therefore when two widely different breeds are crossed the result is commonly not a blend or medium between the two. Even though the progeny may seem to be in the first generation a perfect blend, yet when bred among themselves in the attempt to establish a new breed, it will commonly be found that the descendants break up into three more or less distinct forms.

The proportion of these three groups is constant and interesting. In general, one fourth resemble one parent, one fourth the other, and those resembling neither, or rather showing traces of the influence of both, constitute one half of the whole. This ratio 1:2:1 is the well-known ratio between simple unit characters that do not blend. This is "segregation," and as it is the common behavior, it tends to prove that most characters are units that do not blend in descent but preserve their identity, even though "latent" for a time, reappearing with mathematical regularity.

In the illustrations of segregation, an example was chosen of a character that behaved as a unit. But often in practice what we recognize as a character is made up of several factors, as we know from the fact that it can be broken up and animals bred which show all these various factors separated out in the individual.

For example, the familiar dun color of wild mice is not a real color unit, but is the result of four color factors. If all are present, the dun color results, but if one or more for any reason happen to be absent, a differeht color results. In laboratory experiments, a great variety of colors can be produced at will and in proportions that can be predicted in advance. Curiously enough the binomial formula with the appropriate expansions will express numbers and relative proportions of all combinations that arise in crossing.

**Dominant and recessive characters.** If all characters were equally prominent and evident, the exact composition of each group would stand clearly out. For example when black is crossed with white, the formula is usually 1B, 2BW, 1W, and each group is easily separated. Manifestly, if a red flower should be crossed with a light pink, the formula for the descendants would be 1R, 2RP, 1P. But when it comes to separating the groups, difficulty would arise in distinguishing the pure reds from the mixed red and pink because the stronger red covers up and makes practically indistinguishable the more delicate pink. This being the case, such a crossed population would be separated into two groups, a red and a pink, the red being three times as numerous as the pink. Of course the breeder knows that two thirds of the supposed reds are actually red and pink, but the only way to separate them is by the breeding test.

This overshadowing of one character by another is called "dominance," and the character that overshadows is called "the dominant," while the other is called "recessive." If the desired character happens to be a recessive, it is easily segregated and bred pure, but if it happens to be dominant, its separation from the recessive is a long, laborious job.

The illustration on page 398 and the following extract, which illustrate these matters, are from the unpublished material of Detlefsen and Carmichael of the University of Illinois. They afford a concrete illustration of the manner in which characters behave in crossing:

"The fact that animals and plants may transmit their characters as units can be brought out clearly in domestic animals. If we cross a pure Mulefoot boar with Duroc-Jersey sows, we can follow, among many others, two contrasted pairs of characters coming from these two diverse stocks. The Mulefoot is black (A), whereas the Duroc-Jersey is red (B); furthermore, the Mulefoot has the well-known syndactyl (one-toed) condition in which the digits are fused, whereas the Duroc-Jersey has the cloven hoof (A and B). In the cross, black is dominant to red, and mulefoot is dominant to cloven hoof; hence the crossbreds (C) are both black and mulefooted. Following each pair of contrasted characters separately, we may say that, when these cross breds are mated together,


FIG. 342. Plant of the native wild potato found growing in Colorado. The watch emphasizes its small size as compared with cultivated forms.

they give in the long run: 3 blacks to 1 red, and 3 mulefooted to 1 with cloven hoof. If we follow both pairs of characters simultaneously, we find the crossbreds give on the average 9 black mulefooted (D) + 3 black clovenfooted (E) + 3 red mulefooted (F) + 1 red clovenfooted (G). If the crossbreds are mated back to Duroc-Jerseys, they throw the same four classes in *equal* numbers.

"Not all other characters are transmitted in this simple fashion, for we find many, many complex cases where the interpretation is similar although not so simple. This illustration is a good example in simple terms of several important facts frequently observed in breeding:

"1. Crossing purebreds and then using the crossbreds for breeding purposes, will break up uniformity of type and lead to subsequent variability. This is not only predictable, but the various forms to be expected and their frequencies can by close study be predicted.

"2. New recombinations of characters are not only given to us in this way, but their probable frequency of occurrence is known. Furthermore, one can predict what any animal with a given combination of characters will throw in the next generation; for example, the animal, in Fig. F will throw only red when mated to its own kind, but as to toes, will throw both mulefoot and normal cloven hoof."

The discussion has dealt with but one character in each parent, but it must be remembered that each parent has a great variety of other characters, good, bad, and indifferent, dominant and recessive, all of which go into the makeup of the crossbred progeny. By this it is seen that while crossing offers wonderful opportunities for improvement, the problems involved are extremely complicated, and nobody but the trained experimenter is likely to get results by this road unless it be by merest accident.

The indefinite piling up of generation after generation of characters that tend strongly to preserve their unity, makes breeding an exceedingly complicated art, and knowledge of these facts is what makes older breeders extremely shy about interfering much with those breeds that have been fairly well established by long-continued selection.

The novice, on the other hand, is continually talking about crossing, not realizing that so far as we have fairly satisfactory strains, our greatest progress will lie in still further improvement by continued and consistent selection always reducing the remains of undesirable traits,—hence the value of established breeds.

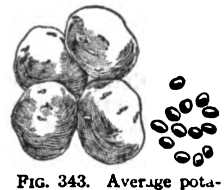


FIG. 343. Average potatoes compared with seedballs from the plant shown in FIG. 342 which produces no tubers.

**THE BUSINESS OF BREEDING.** The business of producing new strains or of improving old ones, is a special line to be undertaken only by those who have plenty of means and whose time can be entirely devoted to the study of the multitude of slightly differing individuals that will appear, every one of which must be made the object of careful study lest a worthless specimen be kept, or, what is worse, a record maker be lost. The farmer having many interests should take over breeds and strains as he finds them in the hands of specialists, and do the best he can to prevent deterioration by going constantly back for new breeding stock, especially sires. If in this way the ordinary farmer can hold his stock level he will do well. The mass of farmers will never raise pedigreed stock. Their chief interest is in other things than livestock, which are kept not for their own sake but as a means to an end,—to market crops, consume waste, make manure, etc. The ordinary farmer will keep unpedigreed stock, if for no other reason than because they are cheaper, knowing that nobody would buy his pedigreed animals at more than ordinary market price. He will raise common, often wrongly called, "scrub stock." Such a man should not raise real "scrub stock," however. He cannot afford to feed good corn and hay to inferior animals, neither can the country afford to have him do it. He should always use purebred sires and depend upon grading to hold his stock at a reasonably high level. This he can afford to do, for it requires nothing extra from him except the occasional purchase of a pedigreed sire, which will many times pay for himself.

**Inbreeding.** Too many uninformed people are afraid of a little inbreeding. There is an unreasoning horror of bringing together blood lines closely related, expressed in such aphorisms as, "nature abhors incest," or in laws that forbid the marriage of cousins. As a matter of fact there is no evidence that close breeding of itself is in any way detrimental. Of course, related lines are somewhat more likely than unrelated to possess *the same defects*, and for this reason they should be closely scanned, but the best results in animal improvement have been obtained by the closest breeding, even of brother and sister, sire and dam. Incest is a moral not a biological sin and, if the stock is good, the breeder may use it quite regardless of consanguinity.

# GEOLOGY

*By* ELMER O. FIPPIN, *formerly Professor of Soil Technology, Cornell University, who wrote the chapters in Volume II on Soils. Edited by* O. D. VON ENGELN, *Assistant Professor of Physical Geography, also in Cornell University. The relation of rocks and soils is so close, and the characters of the one have such an important bearing on the formation and nature of the other, that it is especially gratifying to have had the subject considered by two authorities whose special interests lie along each of these directions. The farmer may not often realize that in handling soils—whether building them up or ruthlessly running them down—he is dealing with materials that have been thousands, possibly millions, of years in the making. Such, however, is the truth, and one that throws a new light on his tasks and responsibilities.*—EDITOR.

**WHAT geology is.** Geology treats of the materials of which the earth is composed, their nature and structure, of the fôrces by which these have been developed, and the age and relationship of their constituent parts. Physiography, which is a branch of geology, has for its particular field the investigation of the form that these materials have on the surface of the earth—that is, the origin of the hills and the hollows and all the other irregularities of the land that give the landscape its different aspects. Geology touches the farmer in innumerable ways. The soil that he cultivates is part of the structure of the earth, and its character is in part determined by the nature of the rock substance from which it has been derived, in part by the changes in that material brought about by various natural processes. Curiously enough, the same processes in turn are largely responsible for the occurrence of the solid rocks that yield the soil. The form of the earth, the steep slopes and the flat plains that so much affect farm operations are the result of the changes to which the earth materials have been subjected. The crust of the earth is in places crumpled up into both small and great folds, some of which reach mountain height. The elevated parts of such folds have often been completely worn down by the long-continued erosion of running water, by the grinding of ice in the form of glaciers, by the action of the wind, and, lastly, by the waves. Most great valleys have been formed by the cutting of rivers supplemented by the decay and crumbling due to the action of the weather. Mountain heights are often simply the projection of the remnants of rocks left behind in the cutting of valleys.

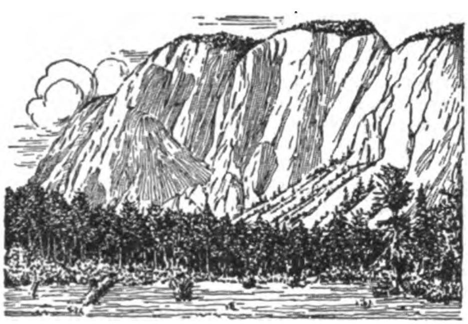


FIG. 314. Mountains may be thought of as projections of hard rock rising out of a softer, more easily weathered surface.

The water supply on the farm depends very much on the structure of the rocks. Porous rocks and soil material afford the reservoir for a large amount of water that is the source of springs. This underground supply of water may also be tapped by wells.

**The climate**, especially the local climate, is very much affected by the form of the land and the position of large bodies of water, and in their relation to the general movement of the wind. Hollows are generally subject to early and late frosts. High points have a colder climate than low areas. High hills and mountains may withdraw the moisture of the atmosphere on one side by deflecting the wind upward so that it is cooled and its moisture content condensed and precipitated as rain or snow. On the opposite side of the elevation

—the lee side—the climate may then be dry, even arid. One of the most striking examples of this particular phenomenon is found along the northwestern part of the United States. The arid and semi-arid climate of much of this western half of the country is due to the fact that high mountains rise in almost unbroken ranges parallel to the Pacific Coast. The seaward slopes of these ranges in northern California, in Oregon and in Washington, have the highest rainfall of any part of the United States, while the inter-mountain valleys only a few miles inland, such as the Sacramento and San Joaquin Valleys, the so-called great American desert of central Nevada, and many other similarly situated valley areas, have an exceedingly dry climate.

The successful growing of apples, peaches and grapes in most of the centers of large production is made possible by a similar adjustment of climate to the land form and its relation to bodies of water. A notable example of this is the Chautauqua grape belt in western New York, comprising a narrow, low plain that fringes the southeast shore of Lake Erie and is backed by a steep bluff. The lake, together with the prevailing direction of the wind, so regulates the temperature and the humidity of this area as to develop a climate particularly suited to the vine.

The building stones, road materials and the various rocks, minerals and ores used in chemical industries have all had a particular geologic history, and have thus acquired a definite place in the earth's structure. Limestone, salt, gypsum, rocks from which cement is made, sulphur and phosphate rock, iron, zinc, copper and lead may be mentioned as examples of such deposits. Coal derived from the accumulation of plants, and the oil and gas that are probably due to the distillation of coal by pressure and heat, are further illustrations.

### Structure of the Earth.

The soil is the last thin covering of the hard rock structure of the earth. Considered in relation to the size of the earth, the soil cover is very thin. Estimating the total average depth used by plants at 10 feet, this would be a layer not over one seventieth of an inch or a "hair's breadth" in thickness on a sphere a mile in diameter, and the earth itself has a diameter of nearly 8000 miles. From this thin layer man and animals derive their plant subsistence. But in many parts of the world and over the greater part of those areas where agriculture is practised, ten feet in depth does not reach solid rock. There lies below the actual soil a thick layer of essentially unconsolidated rock debris that commonly passes under the name of subsoil and is composed of clay, sand, gravel and loose stones. A name that has been proposed for this entire layer of slightly consolidated rock material is *Regolith*, a Greek word meaning literally a stone blanket. If the variably thick but always relatively thin layer of the regolith be stripped off, it will be found that everywhere below the earth's surface a continuous mass of solid rock material occurs. This is bedrock. The consolidated rock extends downward for many miles.

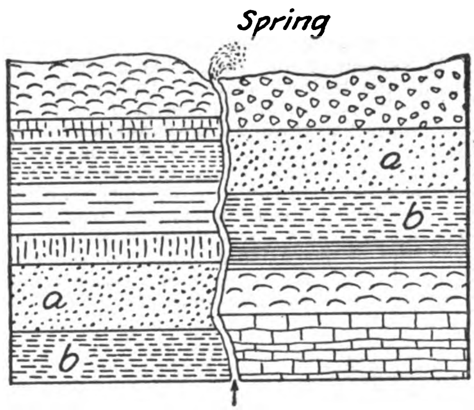



FIG. 345. One result of the movement of the earth's crust is the breaking and shifting of rock layers and the creation of cracks (fault planes) which sometimes permit the escape of water as springs.

**Temperature.** Wherever men have penetrated the earth with mines, tunnels and deep wells, it has been found that the temperature rises with depth. At about 60 feet below the surface, the temperature is approximately constant, the seasonal change on the surface being neutralized by the heat from below. The average rate of increase below 60 feet is one degree Fahrenheit for each 60 to 75 feet. If this rate of increase in temperature continues indefinitely inward toward the center of the earth, it will readily be perceived that at a depth of only a few miles, the temperature would become sufficiently high to

FIG. 346. Joint planes provide entrances for weathering agencies.

melt even the most resistant rocks. It is upon the basis of this knowledge of the rise in temperature, and because of the occurrence of volcanoes that pour out melted rock, that the interior of the earth is considered to be very hot, though probably not in a fluid condition, for the great pressure of overlying material apparently keeps the interior mass rigid.

Density. The earth as a sphere has a rigidity, as indicated by tidal phenomena, greater than that of the hardest steel. The large interior mass is also very dense. The surface rock material with which we are familiar is about 2.7 times as heavy as water, while the earth as a whole is 5.5 times as heavy as water; hence, to balance that of the light shell, the interior must have a density 7.7 times as great as water.

**Movement of the crust.** The crust of the earth—the bedrock material that continues as deeply as men have penetrated—is probably subject to continual up-and-down movement. Some parts are now moving faster than others, so fast in fact that the rate can be measured. On the coast of southern Sweden the land is rising at the rate of 2 or 3 feet in a century. Parts of the coast of Scotland and of our Atlantic Coast are thought to be sinking. The gorge of the Hudson River extends out to sea for a hundred miles and

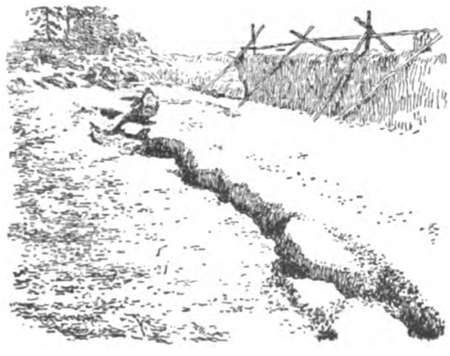


FIG. 347. Sometimes earthquakes cause cracks in the ground like this—or larger.

must have been formed when that area was above the sea.

Results of such movements are the formation of continents and mountains. While the up-and-down movement of the crust of the earth is slow, it none the less involves a vast extent of movement. Great parts of continents and islands appear above the ocean and may later disappear as a result of both erosion and of sinking. The North American continent is far from being a permanent land area. Most of its surface is known to have been below sea level. The lower Mississippi Valley and the Gulf Coast region are both very young as geological time goes.

The cause of such movement is not definitely known but is considered to be due primarily to the cooling of the earth and its consequent shrinkage. The rocks that have become solid at normal atmosphere temperature do not continue to shrink as rapidly as the hotter parts of the earth below. The outer crust consequently is continually becoming too large for the interior and it must, therefore, adjust itself to the contracting interior mass by wrinkling or folding. This is one of the reasons for the formation of mountains, and it also accounts for great depths of the ocean basins. Folding and wrinkling, whatever the cause, is plainly seen in the structure of rocks in such old mountain regions as the Appalachian where even thin strata have been thrown into the most intricate of folds. On the eastern side of the Hudson River in eastern New York, the stratified rocks stand on edge instead of horizontal as they were laid down.

FIG. 348. An extinct volcano showing cone-shaped body and crater or opening.

## Joints, Faults, Earthquakes and Volcanoes

The bending and folding of rocks result in cracks or fissures. In every quarry the quarry men use these fractures or *joint planes* in getting out the rock. If a break occurs suddenly, there may be a jar that is transmitted through the earth and is known as an *earthquake*. Sometimes the edges of the rock that are fractured slip by each other so that they no longer correspond on the two sides. This gives rise to what is known as a *fault* in the rock. Severe earthquakes are frequently the result of a large deep fracture with some faulting or displacement of the rocks. As a result of the *bending* of rocks that were laid down horizontally, their strata are inclined at various angles. The angle at which a stratum of rock slopes is called the *dip*. The di-

rection in which the edge of such an inclined rock layer extends is known as the *strike*. These terms may be made clear when applied to the shingles on a roof. The slope of the roof is the dip. The ridge is the strike.

**Volcanoes.** Under certain conditions, reservoirs of molten rock develop near the surface of the earth and, because of the pressure of included gases, may break out through the surface rocks with explosive violence. Such a breaking forth is a volcano and the phenomenon may be accompanied by extensive fractures of the crust, faulting and severe earthquakes. Great masses of rock, both shattered surface rock and molten material, may be thrown out of volcanic craters with great violence. Large volumes of molten rock or *lava* frequently break out of the side of a vent and flow over the adjacent country. Thousands of square miles in the states of Idaho, Washington and Oregon are covered by material of this sort. On the islands of Hawaii are vast fields of such lava so recently exuded that it is still red hot and steaming

FIG. 349. The effect of weathering on a rock made up of hard and soft portions. The latter wear away first, often undermining the former.

a little way below the surface. Great quantities of gas are frequently discharged which are occasionally poisonous. This was the case in the eruption of Mt. Pelée on the island of Martinique in the West Indies. Here the city of St. Pierre was so completely enveloped in hot, poisonous gas from the eruption that, of a population of 30,000, only two persons survived.

Frequent, also, is the intrusion of lava into fractures in the rocks below the surface, both vertical and horizontal. This molten material cools in its new resting place. Such masses of one-time molten rock that cut rocks of a different kind are known as dykes. In the course of time, if the adjacent rocks are less resistant and are worn away faster, the sheets of intruded rock are exposed at the surface and may give rise to considerable eminences. The Palisades of the lower Hudson River are of this origin.

**Plateaus.** As a result of the folding and unequal elevation of the crust of the earth, areas that were once far beneath the ocean now form high mountain or plateau regions.

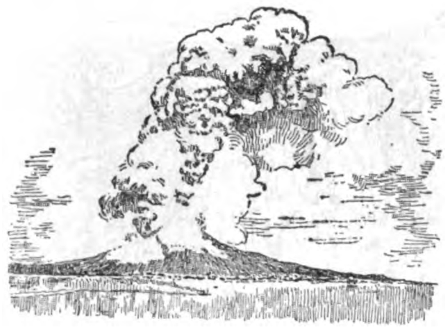


FIG. 350. A volcano in active eruption. Steam and ashes are thrown many miles in the air. Lava or molten rock flows out of the crater and down the slopes.

That this is so is shown by the occurrence of great beds of stratified rock that are known to be formed only beneath the sea but now found hundreds and even thousands of feet above sea level. Limestone is one of the best examples of such a rock type now often found at high elevations.

## Decay and Erosion of Rocks

Mountains, in the sense of elevated lands of limited level summit area, are formed by the wearing away of the surface of the earth by streams, as well as by the wrinkling of the crust. This wearing-away process is greatly aided by the decay and weakening of rocks. Far from being permanent, rocks decay like wood, though by different processes. A number of agencies are at work disintegrating the solid bedrock, especially those portions near the surface of the earth. The constituent minerals are *dissolved* in the rain water. Some of these minerals are more easily dissolved and changed chemically than others, and since the change is usually one giving rise to softer minerals, the rock structure is weak-

FIG. 351. The slow weathering of a granite ledge. Frost, rain, wind and plants—each plays its part

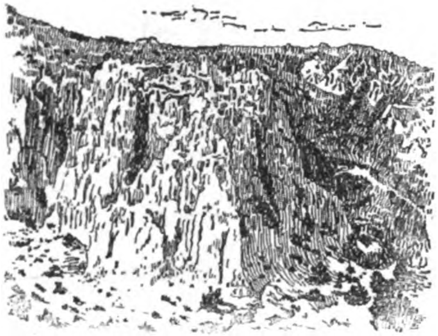


FIG. 352. Clay cliffs in the semi-arid Southwest, carved by occasional rains

ened. Thus, the bedrock mass is made crumbly and its particles are then readily carried away by running water. Some rocks, for example limestone, are rapidly and completely dissolved, and as a result caves, caverns and galleries are formed underground. Of such origin is the Mammoth Cave in Kentucky. *Frost* is exceedingly destructive. As all rocks are somewhat porous and, consequently, take up water, they invite destruction. When the absorbed water freezes and expands, it shatters the rock. Another destructive agency is sand driven by the wind which acts like a file in *wearing away* even the hardest rocks. The fine particles that result can in turn be carried away both by wind and by water. The roots of trees and other plants pry into every fissure in surface rocks and by their expansion during growth widen the fractures. Decaying organic matter added to natural waters increases their solvent power on rock minerals. Moreover, the entire chain of destructive processes acts simultaneously and in coöperation to bring about the decay of rocks. When it is remembered that these weathering processes act in conjunction with the erosive action of every rill, creek and river, the water in which is armed with the sediment it has picked up and that it uses as tools for its scouring action, it is easy to understand that every kind of rock must yield to much destructive attack. In this manner weathering and streams are able to cut great gashes or valleys into the bedrock masses. Go to the top of the higher hills in almost any section of the country and note the valleys that have been carved out between the hills. The course of the stream and the nature of its cutting may have been guided notably by the natural structure of the rock, by the alternation of hard and soft layers, by the presence of joints, dykes and folding. But the main point is that great masses of the bedrock have been carried away. Great mountain systems have been destroyed and the resulting waste cast into the sea by these simple processes that may be observed in every field after a rain and along every water course. The Catskill Mountains in New York, the Bad Lands of the Dakotas, and the vast panorama of cañons on the Colorado River have all been sculptured to their present form by the crumbling due to weathering and the erosive action of streams acting on elevated areas of land.


FIG. 353. Diagram showing how residual soil is formed

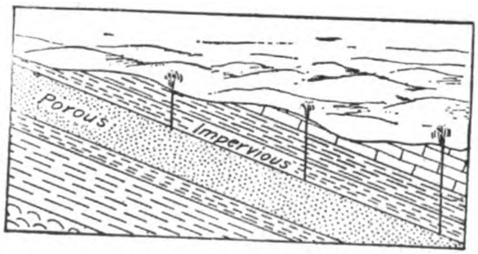



FIG. 354. Diagram showing how artesian wells occur where rock layers of varying degrees of hardness have been inclined by heat and pressure.

**Rock decay in relation to soil.** It is evident that there must be a continual mixing of different kinds of rock material as well as a sorting out of particular constituents, so that a soil casually examined in the field may be a collection of fragments from hundreds of square miles of rock. One of the most notable effects of water is the sorting of the material it handles. As its velocity of flow decreases, it first deposits the coarse and then the finer materials it is carrying. The clay and the silt—the very fine materials—are separated from the sand. The sand in turn is dropped according to its fineness. The gravel and coarser stone are placed by themselves also according to size. The general result of such sorting action is the accumulation of the materials in layers of various kinds, one on top of the other. Even so incomplete an understanding of these processes and of the materials upon which they operate as these few paragraphs afford, will give one a better conception of the soil, and will often aid one in understanding its character and variations.

## Kinds of Rock

Mention has been made of bedrock and that it is variable in character. This calls for a further explanation. Rocks, the solid bedrock material, may be classified in three general groups. First, those that have been formed by the cooling of molten material called *igneous rocks*. Second, those that have resulted from erosion, and the redeposit of the resulting fragments of earlier rocks. These have been laid down either by water or by wind in layers or strata and are known as *stratified rocks*. Third, those formed from either of the first two groups of rock by changes subsequent to their formation resulting from pressure, often accompanied by high temperatures. These forces often totally change the original character of rocks. Accordingly, such rocks are called *metamorphic rocks* from meta, change and morphic, form.

Igneous rocks are of many kinds. Most of them on close inspection reveal different kinds of crystals or minerals. Each of these mineral constituents has a definite chemical composition and a definite crystal form. Granite and trap rock are among the best known varieties of the igneous group of rocks.

Stratified or sedimentary rocks have been deposited by water or wind. The water deposits may be formed by either mechanical or chemical processes. The mechanical deposits were made up of layers of gravel, sand and clay, and formed respectively conglomerate or puddingstone, sandstone and shale.

The chemical deposits were thrown out of solution in the water as precipitates. Examples of these latter are some limestone and all salt and gypsum beds.

Metamorphic rocks result when either of the preceding classes are deeply buried and subjected to great pressure and heat, perhaps in connection with the folding of the rocks. By those forces their character is often greatly changed. Sandstone is further consolidated by the pressure and partial melting, and forms the very resistant rock, quartzite. Shale is changed to slate and its quality of splitting in sheets is developed. Limestone is changed to marble, and peat is changed to coal. Granite and other rocks may be changed to rocks with a banded structure—gneiss and schist.

**The water-table.** In humid regions the entire crust of the earth, both the regolith and bedrock material, at only a short distance below the surface is saturated with water. Some of this water is contained in the actual pores of the rocks and much larger amounts occur in the fissures and cavities. The source of this water is the water that falls on the surface of the earth as rain or snow. Part of this runs off the surface or evaporates. The remainder sinks into the earth and continues to move laterally and downward at a reduced rate. Immediately after a heavy rain the

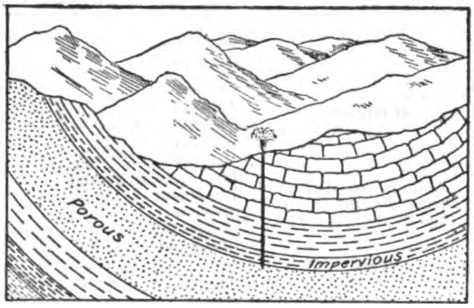



Fig. 355. Another set of conditions producing artesian wells, in which the rock layers have been bent or folded

regolith and bedrock are saturated up to the very surface, but in the succeeding clear days this water sinks away from the surface to conform to the general level of the permanently saturated reservoir below. The top surface of this zone of permanently saturated rock is known as the water-table. It conforms in a general way to the topography of the surface of the land above, but lies deeper under hills than under slopes and valley bottoms. It comes to the surface at the edges of lakes and rivers. The appearance of this underground water at the surface due to a variety of conditions gives rise to springs. Wells sunk below the level of this underground reservoir of water find a permanent supply. Where the water is trapped in a porous rock, by an overlying impervious rock and conducted to great depths and to a much lower level, it develops a high pressure and may be tapped to form a flowing or artesian well.

Oil and gas are also stored in the porous rocks where they are retained by a covering or other enclosure of impervious rocks, commonly shale.

## The Age of Rocks

The age of rocks is determined in part by their relative positions. Usually the lower rocks are older than the upper ones. But the relative position of rocks is not always clear, due to the folding and tilting they may have undergone. Another method of determining the age of stratified rocks is by means of the fossils they contain. A fossil is any remnant or impression of a plant or animal form. Certain plants and animals are characteristic of each age of rocks. In the arrangement of the layers and in the fossil forms the layers contain, much of the geological history of the earth is recorded. From this record it is known that many kinds of plants and animals have developed and flourished for a period only to disappear later. Many of our present forms began their careers far back in those ancient times.

| ERAS | PERIODS | EVENTS |
|---|---|---|
| Cenozoic | Recent<br>Pleistocene<br>Tertiary | Glacial epoch<br>Sierras and Coast ranges formed. |
| Mesozoic (Age of reptiles) | Cretaceous<br>Jurassic<br>Triassic | Rocky Mountains formed at close of period |
| Paleozoic (Abundance of lower forms of plant and animal life.) | Permian<br>Upper Carboniferous<br>Lower Carboniferous<br>Devonian<br>Silurian<br>Ordovician<br>Cambrian | Appalachian Mountains formed |
| Proterozoic | The beginning of life. Ancient continent of Appalachia, now represented by a remnant. The Piedmont plateau then had its largest extent. | |
| Archeozoic | No definite evidence of life. | |

**Main divisions.** The above table* shows the main divisions of geological time (oldest at bottom) with an indication of the nature of the life forms that flourished in the several periods and of some of the associated geologic events in the formation of the North American Continent.

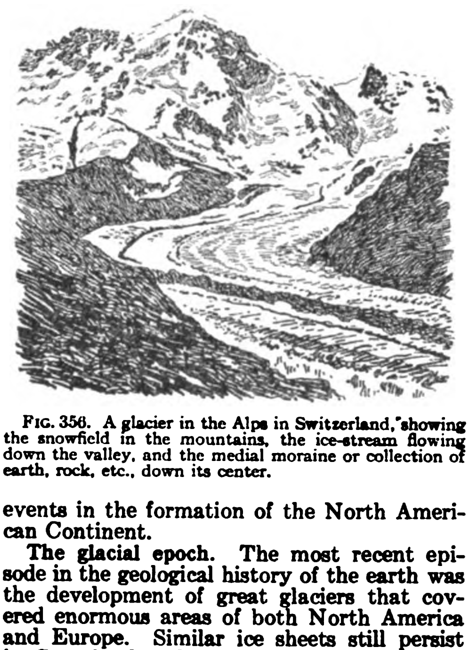


FIG. 356. A glacier in the Alps in Switzerland, showing the snowfield in the mountains, the ice-stream flowing down the valley, and the medial moraine or collection of earth, rock, etc., down its center.

**The glacial epoch.** The most recent episode in the geological history of the earth was the development of great glaciers that covered enormous areas of both North America and Europe. Similar ice sheets still persist in Greenland and over the Antarctic Continent. As ice accumulates in increasing depth it eventually develops so great a pressure that it begins to flow at its bottom and outer edges. If the slope of the country is down hill from the center of ice accumulation, gravity increases this flow action as in the case of small mountain glaciers. During the Glacial Epoch great glaciers developed in Labrador, on the west of Hudson Bay and in the western mountains of Canada in North America, and in Scotland, Norway and Sweden of Europe, of such vast mass that they flowed out over the country southward and westward for hundreds of miles regardless of its topography, overtopping the highest mountains of Maine and the Adirondacks. There is abundant evidence that glacial ice from the Labrador and Hudson Bay centers pushed its way southward—advancing farthest in the valleys and over plains land, but retarded by the hills and mountains, so that eventually it reached a line passing through New York City, northeastern Pennsylvania, Olean, N. Y., Cincinnati, St. Louis and thence along the course of the Missouri river. The Glacial Epoch was not a single incident, though one of its advances may have lasted thousands of years. There is evidence that there have been four such advances of glacial ice followed by retreats of the ice as the result of melting, separated by thousands of years.

**Effect of glaciers on the surface of the earth.** The ice reached thousands of feet in depth and acted as a great mill. It swept away the ancient soil, picked up and ground up rock and carried the material far to the southward where it is mixed with material from other rocks. The fine material ground up by the ice and mixed with boulders is frequently called *rock flour*. That which was deposited below the ice as it melted, is called ground moraine or *boulder till*, and is usually quite compact. That piled up at the margin of the ice where it melted forms *morainic ridges*, and such masses are likely to be loose, partially stratified and with a pitted and uneven surface. As the ice melted and retreated, great rivers and immense lakes were frequently formed in which the material brought in by the ice was sorted, transported and laid down as *stratified clay, sand and gravel*. The shores of these ancient lakes are clearly marked by gravel bars, such as surround Lake Ontario and Lake Erie a few miles back from the present shore line.

**Agricultural interest.** The effect of the glacial incursion on the soils and agricultural

* Based on data in "Geology: Physical and Historical" by H. F. Cleland, 1916.

possibilities of a region was very great. First of all, rocks were ground up without the loss of their plant-food constituents. Hence, glacial soils are relatively rich in such constituents. Of course, this depends very much on the kind of rock the ice acted upon. If it happens to be a lean, hard, old sandstone instead of a granite or limestone, the soil may be very poor. Usually there was enough mixing of material from different kinds of rock to insure a fairly good soil. It should be noted that in glacial regions the soil may bear very little relation to the bedrock on which it rests. Second, valleys were filled and ridges planed down. The surface was rendered more level in general. Regular valleys were largely obscured and many pits and blind hollows were left in the surface of the land. In these have formed innumerable lakes and deposits of peat and muck. Swamps are numerous due to the obstruction of former drainage lines. The streams in the glaciated area have often very irregular meandering courses.

Much of the best agricultural land of the world owes its origin and characteristics to glacial action. The famous corn and wheat soils of the middle-western United States are of this origin. Though much of the area of New England and New York is far from being ideal agricultural land, the soil has been greatly improved in depth, in smoothness of surface and in quality by the glacial incursion.

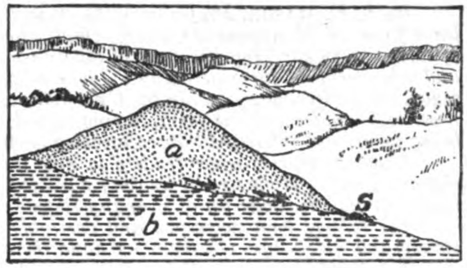



FIG. 357. Showing why and how a spring (S) often appears on a hillside in which a porous stratum (a) overlays a layer of impervious rock (b). The moisture seeps readily through the former along the surface of the latter.

**Glacial soils.** In general, glacial soils are stony, due to the inclusion of fragments that have not been pulverized. They are also highly variable—clay, sand, gravel, and many grades of loam frequently occur in close proximity. Wherever limestone enters into the material used by glaciers, the soil is much improved. For that matter, most soils formed from limestone are above the average in productive capacity.

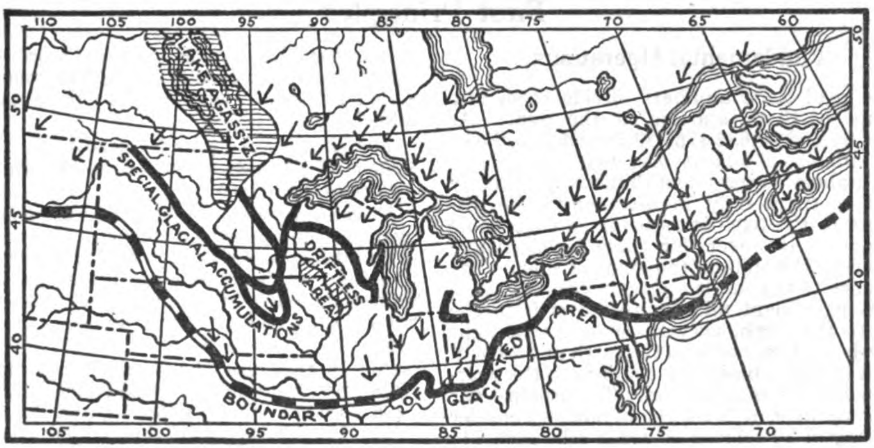



FIG. 358. Showing the area affected by, and the line of farthest advance of, the great glacier that once covered much of North America. The arrows show the course of its advance. Where the boundary line is solid black, the southern limit of the ice advance has been definitely located; where it is broken, white and black, this has only been estimated. Lake Agassiz was formed as the glacier melted, but of this prehistoric inland sea nothing remains but its bed, which scientists have mapped out by studying the soil formation and topography of the region, and a small remnant now known as Lake Winnipeg.

# D. ARITHMETIC

*By* S. E. RASOR, *Professor of Mathematics in the Ohio State University. He was born on a large farm in Montgomery County, Ohio, where he became well acquainted with the practical side of farm life in carrying his share of the duties and chores associated with dairying, tobacco growing and other general farm activities. Later he took up teaching, first in district and township high schools, later in colleges and in the University with which he is now connected. Meanwhile he has never lost contact with the farm, having owned, managed or lived on a farm for most of his life, and being at present interested "in reclaiming some apparently worthless Ohio land."*

*It may surprise some readers to note the simple, primary-grade principles with which this chapter opens. However, in treating a subject that is at the root of so many every-day farm problems, one that is made up of so many steps—each a development or an application of earlier ones—it has seemed both necessary and desirable to begin at the very beginning and to advance very slowly and carefully. On the other hand there are certain branches of higher mathematics, which, though valuable in certain lines of farm work (such as surveying, irrigation, etc.), are really materials only for the scientist and trained professional expert, and which are not discussed here. As far as the farmer is concerned, this chapter covers about every needed rule and principle, together with explanations and illustrations to tie it up with the sort of problems he has to face day by day. The general arithmetical operations cover pages 410 to 417; practical rules and measures used on the farm cover pages 418 to 423; the remaining pages are given up to tables of weights, measures, and equivalents.*—EDITOR.

EVERYONE should be interested in what the world is doing, in our own country and its products. We should all know *definitely* about our farms, our mines, our forests, our great industries, and certainly about the accounts we should keep. Much of interest about these matters is found in Arithmetic.

When we look at our fingers we see why we count, as we do, by tens. Thus, eleven means ten plus one and is written 11; twenty-three means two tens and three more and is written 23; and so on.

## First Principles

### Fundamental Operations

**To read large numbers,** divide them into groups of three, starting at the right. As thus divided 21,685,476,983 *is read* 21 *billions,* 685 *millions,* 476 *thousands,* 983.

Numbers larger than billions are rarely used—perhaps only in astronomy, the distances to the fixed stars being so expressible in miles. However, for these inconceivable distances the mile is too small a unit. The distance to the sun is *eight minutes*, that is, it takes light eight minutes to travel from the sun to the earth, notwithstanding that light travels 7½ times around the earth in a second. With this as a basis, the distance to the nearest fixed star is 2½ years. To visualize our 1917 war debt of 20 billions of dollars, consider a string of 20 billions of dollar bills each 7½ inches long and laid end to end. Such a string would reach 95 times around the earth. By thus increasing the size of the unit on our measuring stick, we are oftentimes better enabled to visualize large numbers. So, too, in the humdrum of everyday duties, life oftentimes means more to us if we try to command a larger view of our surroundings. It is for this purpose of getting a better view of how things are related that we study numbers.

**Addition of numbers is the process of finding** a number that equals two or more other numbers. The result of adding them is called the *sum*. Only like numbers can be added.

*For example, $3 plus $5 equals $8, and is written $3+$5=$8. But 3 eggs+5 turnips is neither eggs nor turnips.*

To *check* or *prove* your work add the columns again in the opposite direction.

In adding a series of columns the results of adding each column are often put down separately, each in its own place, and these results then added. *For example:*

| | |
|---|---|
| 231 | |
| 426 | In this case, the result of adding the |
| 728 | first column (from the right) is 21, the |
| 496 | second column gives 16, and the third, |
| —— | 17. These results then added give the |
| 21 | final result. This is a safe plan for |
| 16 | those unaccustomed to adding. It |
| 17 | saves carrying to the next column and |
| —— | aids in correcting mistakes. |
| 1881 | |

**To subtract one number from another** is to find the *difference* between them. Thus 48 subtracted from 75 is 27 and is written 75−48 = 27.

There are several common methods of subtracting. That method learned in the earlier

grades should be followed. The business man says: "*Deduct* the amount and remit the *balance*," instead of "*Subtract* the amount and remit the *remainder*."

**Making change.** If you owe 72 cents and give the merchant \$1, he says, as he lays down 3 cents: "72 and 3 are 75 and 25 makes a dollar." He thus sees that $\$1 - \$.72 = \$.28$ in which 72 cents is written \$.72.

**Multiplication.** If 7 is taken 4 times, that is, $7+7+7+7$, the result is 28 and is called the *product* of 4 times 7, and written $4\times7=28$. It is shortened addition. It is well to learn a table of all possible products of numbers between 2 and 12, and the number of combinations each can result from. as follows:

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 4 | 6 | 8 | 9 | 10 | $12^2$ | 14 | 15 |
| $16^2$ | $18^2$ | $20^2$ | 21 | 22 | $24^3$ | 25 | 27 |
| 28 | $30^2$ | 32 | 35 | $36^3$ | $40^2$ | 42 | 44 |
| 45 | $48^2$ | 49 | 50 | 54 | 55 | 56 | $60^3$ |
| 63 | 64 | 66 | 70 | $72^2$ | 77 | 80 | 81 |
| 84 | 88 | 90 | 96 | 100 | 108 | 110 | 120 |
| 121 | 132 | 144 | | | | | |

*For example*, $3\times3=9$, $3\times4=12$, $6\times7=42$, $2\times5=10$, $2\times6=12$, $4\times11=44$, etc.

**To multiply any number by 5, multiply by 10 and divide by 2.**

*For example*, $168\times5=\frac{1680}{2}=840$.

**To multiply by 25, multiply by 100 and divide by 4.**

*For example*, $168\times25=\frac{16800}{4}=4200$.

*To multiply by $6\frac14$, multiply by 100 and divide by 16.*

*To multiply by $8\frac13$, multiply by 100 and divide by 12.*

*To multiply by $12\frac12$, multiply by 100 and divide by 8.*

*To multiply by $16\frac23$, multiply by 100 and divide by 6.*

*To multiply by $33\frac13$, multiply by 100 and divide by 3.*

**In** dividing, for example, 99 by 7 which equals 14 with a *remainder* of 1 still to be divided, the result is written $99\div7=14^1/_7$.

To check the result, in the example just given, 14 is multiplied by 7 and the remainder 1 is added, giving 99.

## Fractions

**COMMON FRACTIONS.** If an apple is divided into 4 equal parts, one part is called a fourth, three parts are called three fourths, etc. These are written $\frac14$, $\frac34$, etc. Thus the number into which the unit is divided, 4 here, is called the *denominator*, while the number of parts taken is called the *numerator* of the fraction and is written *above* the denominator with a short line between them.

**To add fractions**, the denominators must be alike. To make them alike we have merely to change the form of the fraction, for example $\frac12=\frac24$, $\frac37=\frac{9}{21}$, by multiplying both numerator and denominator by the same number.

*Example:* $\frac12+\frac23=?$

*Here the least number into which we can divide 2 and 3 is 6. Therefore 6 is to be the denominator for the changed fractions. Thus 1/2 = 3/6 and 2/3 = 4/6 and hence 3 sixths plus 4 sixths is equal to 7 sixths. This is written:*

$$\frac36+\frac46=\frac76=1\frac16$$

*Example:* $\frac13+\frac25+\frac56=?$

*Here the least number we can use for new denominator is 30.*

*Then* $\frac13=\frac{10}{30}$, $\frac25=\frac{12}{30}$, $\frac56=\frac{25}{30}$.

*Therefore* $\frac{10}{30}+\frac{12}{30}+\frac{25}{30}=\frac{47}{30}=1\frac{17}{30}$

**To subtract fractions**, proceed as in addition except that the numerators are subtracted.

*Example:* $\frac12-\frac{5}{12}=?$ *The least denominator permissible here is 12. Thus* $\frac12=\frac{6}{12}$ *and then* $\frac{6}{12}-\frac{5}{12}=\frac{1}{12}$ *the required result.*

*Example:* $\frac34-\frac13=?$ *Here 12 is again the least denominator that contains both 3 and 4. Therefore,*

$$\frac34=\frac{9}{12},\ \frac13=\frac{4}{12},\ \text{and}\ \frac{9}{12}-\frac{4}{12}=\frac{5}{12}$$

**To multiply fractions**, multiply all the numerators together for a new numerator, and all the denominators together for a new denominator.

*Example: Three fourths of (or times) eight ninths is written*

$\frac34\times\frac89=\frac{3\times8}{4\times9}=\frac{24}{36}=\frac23$. *Here as at other times we may often cancel to advantage.*

*Thus*, $$\frac34\times\frac89=\frac{\cancel{3}\times\cancel{8}^{2}}{\cancel{4}\times\cancel{9}_{3}}=\frac23.$$

*Example:*

$$\frac56\times\frac{12}{35}\times\frac{14}{15}=\frac{\cancel{5}\times\cancel{12}^{2}\times\cancel{14}^{2}}{\cancel{6}\times\cancel{35}_{7}\times15}=\frac{2\times2}{15}=\frac{4}{15}$$

**To multiply mixed numbers, reduce each to the fractional form and multiply.**

*Examples:* $5\frac{2}{5}\times 3\frac{3}{4}=\frac{27}{\cancel{5}}\times\frac{\cancelto{3}{15}}{4}=\frac{81}{4}=20\frac{1}{4}.$

$\frac{1}{15}\times 45\frac{1}{2}\times 33\frac{1}{3}\times 16\frac{7}{8}=?$

*Here* $45\frac{1}{2}=\frac{91}{2}$, $33\frac{1}{3}=\frac{100}{3}$ *and* $16\frac{7}{8}=\frac{135}{8}$.

*The work may be arranged as follows:*

$$\frac{1}{\cancel{15}}\times\frac{91}{2}\times\frac{\cancelto{25}{100}}{\cancel{3}}\times\frac{\cancel{135}}{\cancelto{2}{8}}=\frac{91\times25\times3}{4}=\frac{6825}{4}$$
$$=1706\frac{1}{4}.$$

**To divide by a fraction invert the one by which we are dividing and then multiply.**

*Example:* $\frac{5}{8}\div\frac{3}{4}=\frac{5}{\cancelto{2}{8}}\times\frac{\cancel{4}}{3}=\frac{5}{6}$

$4\frac{1}{3}\div 2\frac{3}{5}=\frac{13}{3}\div\frac{13}{5}=\frac{\cancel{13}}{3}\times\frac{5}{\cancel{13}}=\frac{5}{3}=1\frac{2}{3}.$

DECIMAL FRACTIONS. *A decimal fraction*, usually called a *decimal*, is merely an ordinary fraction whose denominator is a multiple of 10.

*For example:* $4\frac{7}{10}$ *may be written* $4.7$; $\frac{125}{1000}$ *is written* $.125$.

The *decimal point* is the period placed to the right of the *units* and to the left of the *tenths* place. Thus .7 means $\frac{7}{10}$, .26 means $\frac{26}{100}$, $45.263=45\frac{263}{1000}$. The latter is read forty-five *and* two hundred sixty-three thousandths.

The comparison of decimal and common fractions is seen in writing checks. Thus a check for $3.25 is so written at one place on the check and at another it is usually written "Three and 25/100.... Dollars."

**Decimals are added or subtracted** just as whole numbers, keeping the decimal points under one another. Thus 1.09 + .251 is written

$$\begin{array}{r}1.09\\ .251\\ \hline 1.341\end{array}$$

and added in the usual way.

**To multiply decimals,** proceed as with ordinary numbers and preserve in the product as many decimal places as there are in *both* of the numbers multiplied. Thus, 6.2 × .31 = 1.922.

**In dividing decimals,** therefore, the number of decimal places in the answer is equal to the *difference* of the number of decimal places in the given numbers. Thus, 1.922 ÷ 6.2 = .31.

**COMPOUND NUMBERS.** A number composed of different kinds of units that are related to each other is called a "compound number"; as 2 bu. 3 pk. 1 qt. Here quarts, pecks, bushels are related to each other, since 4 pk. = 1 bu., and 8 qt. = 1 pk. This number then reduces to 11 pk. 1 qt. and this to 88 qt. + 1 qt. = 89 qt.

Various kinds of measures are necessary in modern life. Some of these are given on page 423 of this Chapter.

**Addition and subtraction of compound numbers:**

*Example: Find the sum of 7 hr. 32 min., 12 hr. 24 min., 20 hr. 13 min.*

| hr. | min. | |
|---|---|---|
| 7 | 32 | The sum of the min. = 69 min., but this = 1 hr. 9 min. Write the 9 min. under the min. column and add the 1 hr. to the hr. column, etc. |
| 12 | 24 | |
| 20 | 13 | |
| 40 | 9 | |

40 hr. 9 min. = 1 da. 16 hr. 9 min. *Ans.*

*Example: From 36 gal. 2 qt. 1 pt. take 19 gal. 3 qt. 2 pt.*

| gal. | qt. | pt. | |
|---|---|---|---|
| 36 | 2 | 1 | *As 2 pt. cannot be taken from 1 pt., a qt. or 2 pt. is borrowed from the qt. column and added to the pt. column. Thus 2 pt. from 3 pt. = 1 pt.* |
| 19 | 3 | 2 | |
| 16 | 2 | 1 | *Continue in the same way for the other columns.* |

*16 gal. 2 qt. 1 pt. Ans.*

**Difference between dates.**

*Example: Find the time from July 4, 1856, to Jan. 1, 1917.*

| *yr.* | *mo.* | *da.* | |
|---|---|---|---|
| *1917* | *1* | *1* | *It is customary to consider 30 days to the month in estimating time. July is the 7th month and Jan. is the 1st month.* |
| *1856* | *7* | *4* | |
| *60* | *5* | *27* | |

*60 yr. 5 mo. 27 da. Ans.*

## Percentage

**Per cent.** *Per cent,* often written %, means *hundredths*. Thus 6% of anything means .06 of it. However, the common fraction form is often advantageous.

| | | | | | |
|---|---|---|---|---|---|
| *1%* | *= .01* | $=\frac{1}{100}$ | $8\frac{1}{3}\%$ | *= .083+* | $=\frac{1}{12}$ |
| *10%* | *= .10* | $=\frac{1}{10}$ | $16\frac{2}{3}\%$ | *= .166+* | $=\frac{1}{6}$ |
| $12\frac{1}{2}\%$ | *= .125* | $=\frac{1}{8}$ | $33\frac{1}{3}\%$ | *= .333+* | $=\frac{1}{3}$ |
| *20%* | *= .20* | $=\frac{1}{5}$ | $37\frac{1}{2}\%$ | *= .375* | $=\frac{3}{8}$ |
| *25%* | *= .25* | $=\frac{1}{4}$ | $62\frac{1}{2}\%$ | *= .625* | $=\frac{5}{8}$ |

**To find a certain per cent of a number,** as 6% of $250, we take .06 of $250 as in decimals, giving $250 × .06 = $15.00.

*Example: How much butter fat in 48 lbs. of 3.2% milk and what is it worth when butter is selling at 50¢ per lb., estimating by the usual rule that 1 lb. butter fat = $116\frac{2}{3}\%$ of its weight in butter?*

*48 lb. × .032 = 1.536 lb. butter fat.*
*1.536 lb. ×* $1\frac{1}{6}$ *= 1.792 lb. butter.*
*1.792 lb. butter @ 50¢ = $.896 = 90¢.*

*Example: A poultry meal contains 22.9% protein, 5.27% fat and 5.41% fiber. Find the amount of each in 400 lb.*

*400 lb. × .229 = 91.6 lb. protein,*
*400 lb. × .0527 = 21.08 lb. fat,*
*400 lb. × .0541 = 21.64 lb. fiber.*

**To find that number of which a certain per cent is given.**

*Example: How many pounds of 3.5% milk must a cow give to produce 5 gallons—about 42 lb. of cream?*

*Here, .035 of the required amount = 42 lb., then the required amount = 42 lb. ÷ .035 = 1200 lb.*

**To find what per cent one quantity is of another.**

*Example: 8 is what per cent of 40?*
*8 is $\frac{1}{5}$ of 40, that is, it is .20 or 20% of 40.*

*Example: What is the % gain when a farmer gains \$25 on a horse that cost him \$120?*

*\$25 is $\frac{25}{120}$ or .21, that is, 21% of \$120.*

*Example: What is the per cent depreciation on a harvester that cost \$140 and was sold after one year for \$75?*

*The depreciation was \$140 − \$75 = \$65.*

*\$65 is $\frac{65}{140}$ or $.46\frac{3}{7}$, that is, $46\frac{3}{7}$% of its cost.*

## Interest

*Interest* is money that is paid for the use of other money called the *principal.* Interest at 6 per cent means 6% or .06 of the principal for one year regarded usually as 12 months of 30 days each.

*Example: What is the interest on \$241.50 for 3 yr. 4 mo.?*

```
 $241.50
      .06
 $14.4900 interest for 1 yr.
       3⅓
   43.47
    4.83
 $48.30 interest for 3⅓ yr.
```

*Example: Find the interest on \$375 from September 10, 1907, to Aug. 7, 1910, at 6%.*

```
Time to run:  1910— 8— 7
              1907— 9—10
              2 yr.—10 mo.—27 da.
 $375
   .06
 $22.50 interest for 1 yr.
      2
 $45.00 interest for 2 yr.
10 mo. = 10/12 of 1 yr.
 $18.75 interest for 10 mo.
27 da. = 9/100 of 10 mo.
 $ 1.6875 interest for 27 da.
 $65.4375
```

*Total interest therefore is \$65.44.*

## Borrowing from a Bank

**Borrowing from a bank.** *To borrow money from a bank* is exactly the same as borrowing from an individual *except* that at a bank *the time is usually for short periods* and *the interest is paid in advance.*

The following is the usual form of *promissory note.* It must always contain the words "For Value Received":

> $______ *New York,*______*191*___
> __________*after date*__*promise to pay to*
> *the order of*________________
> ____________________*Dollars*
> *at* ____________________
> *For value received*
> *No.*____*Due*____ ____________

In this note no interest is mentioned, since at a bank the interest is paid in advance. On the above note Henry Smith would obtain \$150 less the interest for 60 days which is \$150 − \$1.50 = \$148.50. Discounting a note in this way is called *Bank Discount.*

## Square Root

*One of two equal* factors of a number is called the *square root* of the number. Thus since 4 times 4 = 16, 4 is called the square root of 16. It is written $\sqrt{16} = 4$, and is read, the square root of 16 equals 4.

*Example: what is the side of a square field which contains four acres?*

*Since 4 acres = 640 sq. rods we must extract the square root of 640 as follows:*

```
      6̇40.0̇0|25.3
      4
 45 | 240
    | 225
503 | 1500
    | 1509
```

*Point off the number into periods of two figures each, whole numbers to the left, decimals to the right, placing dots as shown. Find the greatest square in the left hand period and place its root to the right. This is 2 in the example. Subtract this square from the period and bring down the next period. Next,* double the root *found. This gives 4 which is set down to the left of 240 the new remainder. As a trial division 4 divides into 24 about 5 times since on trial 6 would be too large. This 5 is now* annexed *to the 4 giving 45 to the left of 240 as shown. It is also annexed to the 2 in the root. Now multiply 5 times 45 and subtract it from 240. Again, bring down the next period. Then double the root found, viz., 25, giving 50, which is written to the left of the remainder as before. The trial division of 50 into 150 gives 3 as the next figure of the root. Thus a field 25.3 rods each way contains 4 acres.*

*Example: Extract the square root of 1467.85.*

$$
\begin{array}{r|l}
 & 14\dot{6}7.85 \,|\, \underline{38.3} \\
 & 9 \\
\hline
68 & 567 \\
 & 544 \\
\hline
763 & 2385 \\
 & 2289 \\
\hline
 & 96
\end{array}
$$

**AVERAGES.** The *average* of two quantities of the same weighted value is one half of their sum.

A board is 6 in. wide at one end and 10 in. at the other end. Its average width is thus ½ of 6+10; that is, 8 in. Again, the average temperature of 10 gal. of water at 32° and 4 gal. at 60° is

$10 \times 32°$ plus $4 \times 60°$ divided by $10 + 4$ gal;

that is $\frac{320 + 240}{14} = 40°$.

If a farmer has 10 bushels of corn with ears 6 in. long. and 5 bushels with ears 10 in. long, the *average length of ear* is

$$\frac{10 \times 6 + 5 \times 10}{10 + 5} = \frac{60 + 50}{15} = 7\tfrac{1}{3} \text{ in.}$$

*Example: A farmer has a Jersey cow that gives daily 5 gal. of 5% milk and two Holstein cows that give 14 gal. of 3% milk. What is the per cent of butter fat of their mixture?*

$$\frac{5 \times .05 \text{ plus } 14 \times .03}{5+14} = \frac{.25 + .42}{19} = \frac{.67}{19} = .035;$$

*that is, the mixture is a 3.5% milk.*

*Example: In a civil-service examination a candidate makes a grade of 70% in arithmetic which is to count 5 points, 80% in penmanship which is to count 1 point, 90% in geography which carries a weighted value of 2 points. What is the final grade?*

$$\frac{5 \times 70\% + 1 \times 80\% + 2 \times 90\%}{5 + 1 + 2} = 76\tfrac{1}{4}\%,$$ *the final grade.*

## Mensuration or Measuring

**THE CIRCLE.** *A circle* is a plane figure bounded by a curved line called the *circumference*, every point of which is equidistant from a point within called *the center*. A line through the center terminating at both ends on the circumference is the *diameter*. The line from the center to the circumference is the *radius*. Any portion of the circumference is an *arc*.

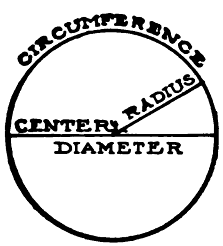



FIG. 359. A circle and its parts

The circumference of any circle is always 3.1416, approximately 3 1/7 times the diameter. The symbol usually used for this constant is the Greek letter $\pi$ (*pi*).

Thus, *Circumference* = $\pi$ *Diameter.*

**The area of a circle is $\pi$ times the square of the radius; or is equal to one half of the circumference times the radius;**

***that is,*** *Area of circle* = $\pi$ *square of radius,*
= 1/2 *circumference times radius.*

*Example: Find the circumference and the area of a circle whose radius is 8 in.*

*Circum.* $= 2\, \pi\, 8 = 16 \times 3.1416 = 50.3$ *in.*

*Area* $= \frac{1}{2}\,(50.3 \times 8) = 201.2$ *sq. in.*

**ANGLES.** Angles are used to measure (in degrees) a turning movement and also to measure a difference in direction. A circle contains 360°. This is a complete turn. A quarter turn, called a right angle, thus contains 90°. When two lines form a right angle they are perpendicular to each other.

In a practical way, angles are measured on a drawing by a semi-circular scale called a *protractor*. In the field, a surveyor's transit is usually used.

**A TRIANGLE** is a plane figure bounded by 3 straight lines. When the sides are equal

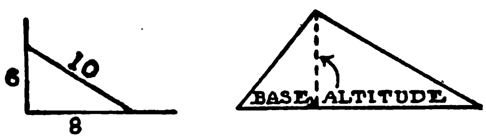



FIG. 360. The parts of a triangle and (*left*) the ratio between the length of the sides of a right triangle

in length, the angles are also equal and the triangle is called *equilateral*. If 2 sides are equal 2 angles are equal, and it is called *isosceles*. When one of the angles of a triangle is a right angle, it is a *right triangle*. In this case, the side opposite the right angle is called the *hypotenuse* and the other two sides are called the *legs*.

**In a right triangle the square of the hypotenuse is equal to the sum of the squares of the other two sides or legs.**

A farmer conveniently squares a building by measuring from a corner 6 ft. along one side and 8 ft. along the other side. A 10 ft. pole then just fits the ends of these measurements when the corner is square, since

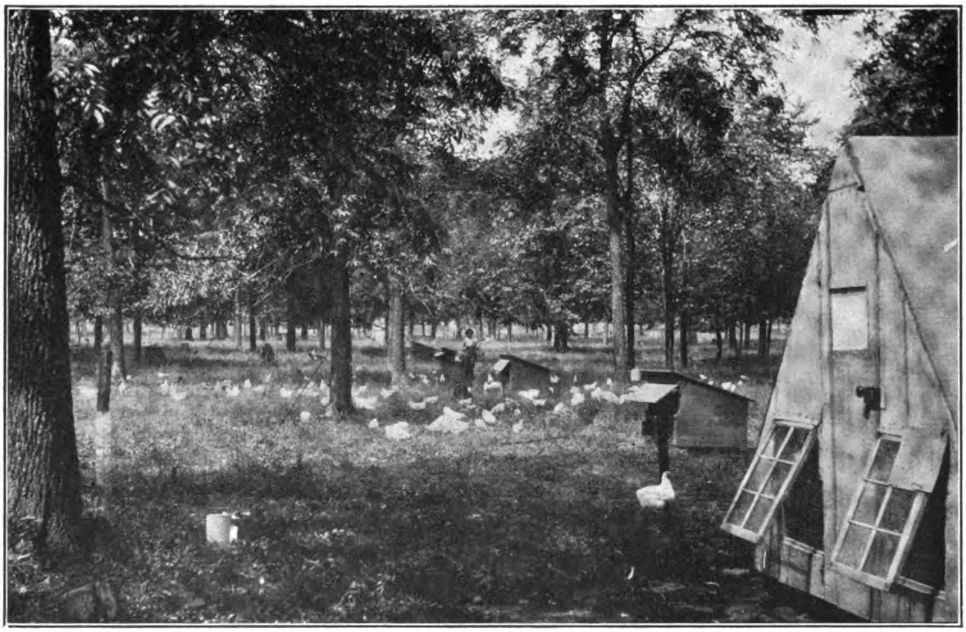
$$6^2 + 8^2 = 10^2 \text{ i.e.}$$
$$36 + 64 = 100.$$

**The altitude of a triangle is the perpendicular distance from any corner to the opposite side.**

**The area of a triangle is equal to the base times one half the altitude.**

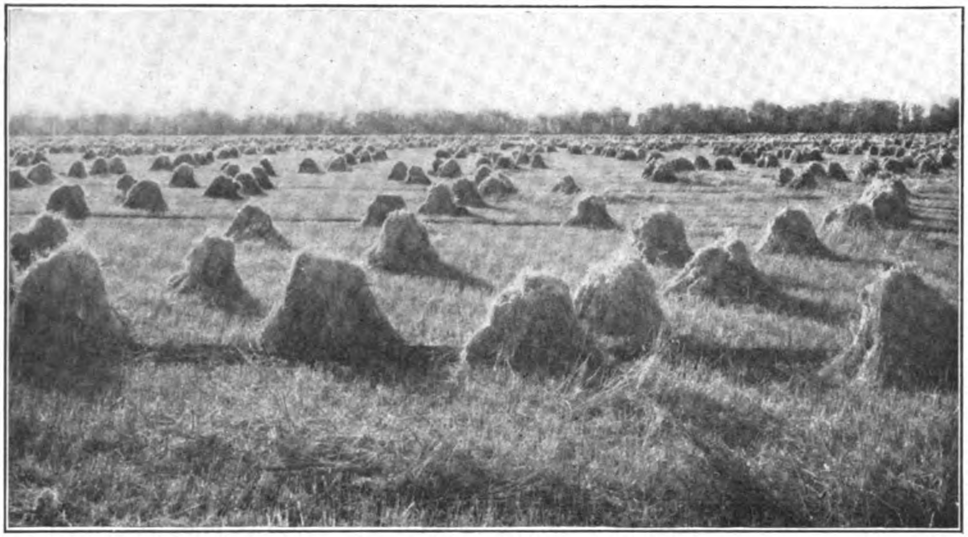
**If the three sides are given, the area is found as follows: Add the three sides together and take one-half of the sum: from this half sum subtract each side separately.**

Science tells us what feeding does and how, normally, we should do it. But the animal given free rein is the best judge of all of what it wants and needs



Exercise is as much a need of the body as food or water; the more active the animal, the more exercise it needs. This is an ideal poultry range

THE MOST SUCCESSFUL FARMER IS HE WHO COMBINES ALL THAT SCIENCE, HIS OWN PRACTICAL EXPERIENCE, AND THE WORK OF OTHER FARMERS HAVE TAUGHT HIM, AND THEN MAKES RULES AND DEVELOPS METHODS TO FIT HIS OWN NEEDS



This is obviously good wheat land. The wise farmer in working it will choose his rotations and methods with that fact ever in mind

How did the farmer who planted this orchard know that apples were *the* crop for this soil and location? This is the kind of problem that makes farming the complex, difficult business it is

**As Certain Soils are Best for Certain Crops so Certain Sections of the Country are Best for Certain farmers. The Thing is to Find YOUR Place and Then Stay There**

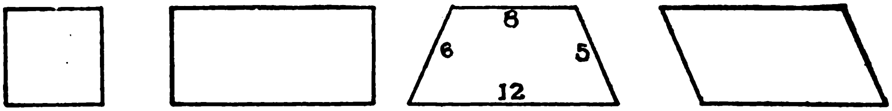



FIG. 361. Quadrilaterals, from left to right: square, rectangle, trapezoid, parallelogram.

**Now multiply the three remainders and the half sum together and extract the square root of the product. This gives the area.**

*Example: A farmer has a triangular field whose sides are found to be 10, 12 and 14 rd. What is its area?*

$\frac{10 + 12 + 14}{2} = 18$. *This is the half sum.*

$18-10=8$
$18-12=6$
$18-14=4$ *These are the three remainders.*

*Then* $18 \times 8 \times 6 \times 4 = 3{,}456$. *The square root of this is 59 (nearly) square rods, the area.*

**QUADRILATERALS are any four-sided plane figures. When the sides are all equal and the angles right angles it is called a *square*. In a *rectangle* the angles are all right and the opposite sides equal. If only 2 sides are parallel it is a *trapezoid*, while in a *parallelogram* the opposite sides are *parallel* and *equal* whatever the angles may be. (Fig. 361.)**

**A five-sided figure is called a *pentagon*. A six-sided one is a *hexagon*.**

**The area of a square, or a rectangle, or a parallelogram is equal to the base times the altitude (the distance between parallel sides).**

**The area of a trapezoid is the altitude times one half the sum of the parallel sides.**

*Example: The parallel sides of a field in the form of a trapezoid measure 8 rd. and 12 rd. Find the area if the altitude is 7 rd.*

$\frac{8 + 12}{2} = 10$. *This times the alt. is* $10 \times 7 =$ *70 sq. rd., the area.*

**The area of irregular-shaped fields may be found by dividing them into triangles, rectangles, trapezoids, etc. and taking the sum of the areas of each of these divisions.**

*Example: A farmer has an irregular field between a road and the river. Find its area by measuring the lengths of the sides and the lengths of the diagonals connecting opposite corners as shown in Figure 362.*

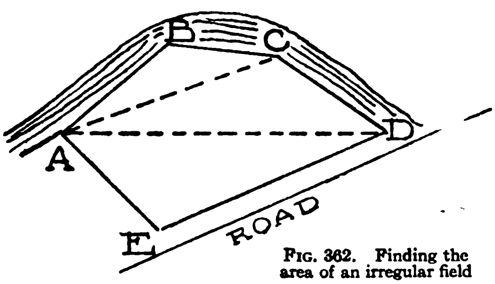



FIG. 362. Finding the area of an irregular field

*The distances measured in straight lines are:*

| | | | |
|---|---|---|---|
| *AB* | = *30 rods* | *AC* | = *45 rods* |
| *BC* | = *21* " | *AD* | = *60* " |
| *CD* | = *24* " | | |
| *AE* | = *27* " | | |
| *ED* | = *54* " | | |

*The area is thus the area of the triangles ABC, ACD, ADE, whose sides are known.*

*Ans. 1472 sq. rd. This divided by 160 sq. rd. in an acre = 9 1/5 acres.*

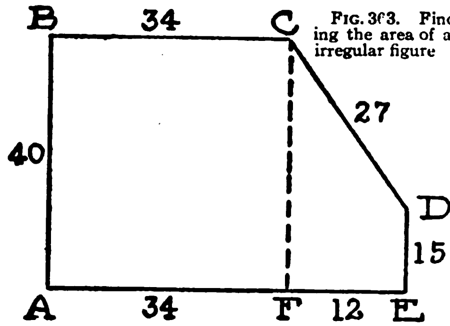



FIG. 363. Finding the area of an irregular figure

*Example: Find the area of the field as shown in Figure 363, above, the measurements being in rods.*

*ABCF is a rectangle whose area is 34 rd.* $\times$ *40 rd. = 1360 sq. rd.*

*CDEF is a trapezoid whose altitude is 12 rd. and the parallel sides 40 rd. and 15 rd. Its area is therefore*

$$\left(\frac{40 + 15}{2}\right) \times 12 = 330 \text{ sq. rd.}$$

*The total area of the field is therefore 1360 sq. rd. + 330 sq. rd. = 1690 sq. rd. = 10 A. 90 sq. rd. = 10 9/16 acres.*

**The volume of a prism of rectangular shape is found by multiplying the area of one end by the length, using the same unit in all measurements.**

**The volume of a cube is equal to the cube of an edge.**

**The volume of a cylindrical solid is equal to the area of the base times the height.**

**The volume of a pyramid or of a cone is equal to the area of the base times one third**

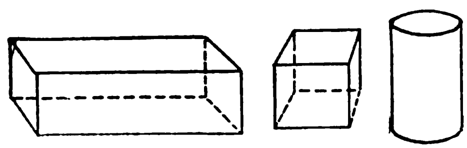


FIG. 364. Solids, from left to right: prism, cube, cylinder

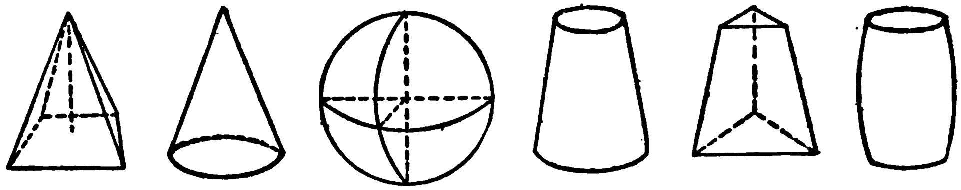


FIG. 365. Solids, from left to right: pyramid, cone, sphere, frustum of cone, frustum of pyramid, barrel

of the altitude, the altitude being the perpendicular distance from the base to the highest point.

The volume of a frustum of a pyramid or of a cone is found as follows: Add together the areas of the upper base, the lower base, and the square root of their product. Multiply this sum by one third of the distance between the bases.

The lateral surface of a pyramid or of a cone is equal to the distance around the base times one-half of the slant height.

The volume of a sphere is equal to 4/3 times $\pi$ (3 1/7, nearly) times the cube of the radius, i.e.

$$V = \frac{4}{3} \pi R^3.$$

The surface of a sphere is equal to 4 $\pi$ times the square of the radius.

The volume of a barrel may be estimated roughly by regarding it as a cylinder with the same height as the barrel, but with a diameter equal to half the sum of head and bung diameters.

*Examples: 1. A bucket is 12 in. deep with upper diameter 10 in. and lower diameter 8 in. Find its volume in gallons.*

*It is a frustum of a cone.*

$\pi\, 5^2 = 25\, \pi$, *area of upper base.*

$\pi\, 4^2 = 16\, \pi$, " " *lower* "

$\sqrt{25\, \pi\ 16\pi} = 20\, \pi$, *the square root of their product. Therefore the volume is* $(25\, \pi + 16\, \pi + 20\, \pi)$ *times one third of 12, the altitude. This gives*

$$61\, \pi \times 4 = 244\, \pi = (244)\,(3\tfrac{1}{7}) = 767 \text{ cu. in.}$$

*Since there are 231 cu. in. in a gallon, 767 cu. in. = 3.32 gal. = 3 1/3 gal. nearly.*

*2. A conical pile of sand measures 8 ft. in diameter at the base and is 3 ft. high. Find the number of "yards" (27 cu. ft.) in it.*

*$4^2\pi = (16)\,(3\tfrac{1}{7}) = 50.3$ sq. ft. the area of the base. (50.3) times 1/3 of 3 = 50.3 cu. ft. = 1.9 cu. yds. nearly.*

Similar figures are those that have the same shape.

The areas of similar figures are to each other as the *squares* of any corresponding dimensions; the volumes of similar solids are to each other as the *cubes* of corresponding dimensions.

*Example: A farmer has two strings of drain tile, of diameters 3 in. and 4 in. What size tile shall he use to combine them into one drain?*

*They are related to each other as the squares of their diameters, i.e. $3^2 + 4^2 = 25$. This is the square of the diameter of the tile which is equal to the other two, that is, its diameter = 5 in.*

*Example: How do two oranges, diameters 2 in. and 3 in. compare in volume?*

*Their diameters are to each other as 2 to 3; therefore their volumes are to each other as $2^3$ to $3^3$, that is, as 8 to 27.*

# Rules and Measures

## Practical Measurements

1. Estimating the height of a tree is perhaps easiest done by measuring the length of the shadow of a vertical pole and the length of the shadow of the tree. In figure 366, ED is the tree, AD its shadow, CB the pole, and AB its shadow. Hence

$$\frac{\text{height of tree}}{\text{shadow of tree}} = \frac{\text{length of pole}}{\text{shadow of pole}}$$

*i.e.* $$DE = \frac{AD \times BC}{AB}$$

*Example: What is the height of a tree if its*

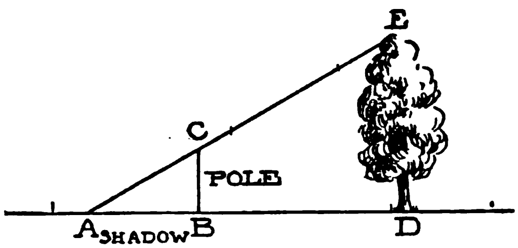



FIG. 366. Estimating the height of a tree; method 1

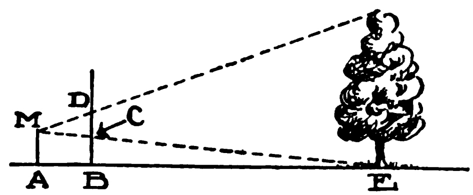



FIG. 367. Estimating the height of a tree; method 2. See p. 419

*shadow is 66 ft. at the same time that a ten-foot vertical pole casts a shadow 8 1/2 ft. long?*

$$DE\ (\textit{height of the tree}) = \frac{10 \times 66}{8\ 1/2} = \frac{660}{8\ 1/2} = 78\ ft.$$

2. **Finding height of a tree by sighting.** A man stands at A (Fig. 367) and sights along a vertical pole BD to the top and to the bottom of the tree: at the same time having an assistant mark the line of sights on the pole at C and at D. The distances CD, CM, ME are then measured. For practical purposes the distance ME may be taken equal to AE on the ground. Then

$$\text{height of tree} = \frac{CD \times AE}{MC}$$

3. **Distance across a swamp, both sides accessible.** (Fig. 368.) Lay off AC = CE in a straight line and through C take BC = CD in a straight line. Then measure DE. This is equal to the required distance AB.

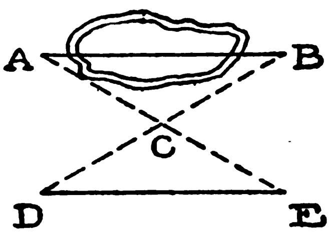



FIG. 368. Estimating the distance across a swamp

4. **Distance across a river or a swamp** may be estimated by use of a vertical staff AE (Fig. 369) to which is attached, at right angles, a movable arm CD. The observer raises DC so that C falls in the line of sight EB. Now by simply revolving the arm DC around the staff he locates B′. Then AB′ which = AB, is measured and is the distance required.

This method just given may be carried out by a man standing at A with his eyes at E. He now raises or lowers his head till the edge of his hat brim at C falls in the line of sight to the object at B. Then, without raising or lowering the head, he turns about and observes the point B′ where the line of sight strikes the ground. The distance AB′, = AB as above, is the distance required.

5. **Distance of visibility on a level plain.** If one climbs a tree, he can see farther on a plain than when on the ground. The distance one can see is given as follows:

Multiply the height in feet by 3/2 and extract the square root. *This is the distance in miles.*

*Example: How far can a man see on a level plain from the top of a tree 54 ft. high? If 150 ft. high, how far can he see?*

$54 \times \frac{3}{2} = 81$. *The square root of this is 9. Hence he can see 9 miles.*

*Also* $150 \times \frac{3}{2} = 225$. *The square root of this is 15 miles.*

**LUMBER MEASURE.** A board 1 ft. square and 1 in. thick, called a board foot, is the unit in measuring lumber. In practice a board 1 ft. square and 3/4 or 7/8 in. thick also is called a board foot. Dealers usually speak of board feet as feet. In practice, 2 ft. 6 in. is usually written 2′ 6″. Lumber is usually sold at so much "per M," that is, per 1,000 ft. B.M. (board measure).

In billing 5 pieces 2″ by 4″ and 14′ long the form is 5 pc. 2″ × 4″ × 14′.

This would be read "5 two-by-four 14 ft."

**To find the number of board feet in a piece of lumber,** *multiply the length in feet by the width and the thickness in inches and divide by* 12.

Thus, 15 pc. 2″ × 4″ × 18′ will contain

$$\frac{15 \times 18 \times 2 \times 4}{12} = 180 \text{ feet.}$$

At $3.00 per hundred, or 3c per foot, this would cost $5.40.

**To estimate lumber in the log,** Doyle's rule, widely used, is as follows: *Subtract 4″ from the smallest diameter in inches; take 1/4 of this remainder and square it; then multiply by the length of the log in feet.*

*Example: How many feet of lumber in a log 26 ins. in diameter and 18 ft. long?*

$26'' - 4'' = 22''$. *One-fourth of* $22 = \frac{11}{2}$.

$\frac{11}{2} \times \frac{11}{2} \times .18 = 545$ *ft. nearly.*

**To find the side of the largest squared piece of timber** *that can be cut from a given log.*

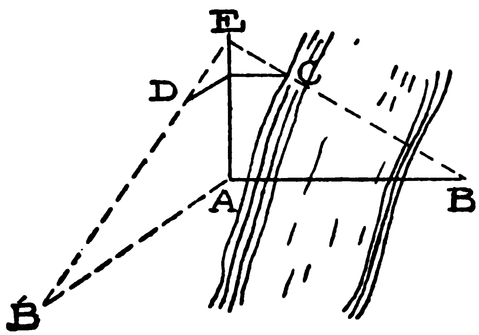



FIG. 369. Estimating the distance across a river

(1) **When the diameter of the log is known,** the side of the largest squared piece obtainable from it is equal to 7/10 of the diameter. For example, if the log is 16″ in diameter, the side of the largest squared piece is 16 × 7/10 = 11″.

(2) **When the circumference only is available,** divide the circumference by 3 1/7 and

multiply the result by 7/10. For example, a log whose circumference is 62″ yields a squared piece whose side is

$$62 \div 3\frac{1}{7} \times \frac{7}{10} = 62 \times \frac{7}{22} \times \frac{7}{10} = 13.8''.$$

**ESTIMATING WOOD AND COAL.** Cordwood is 4 ft. long. A pile 8′ × 4′ × 4′ is called *a cord of wood*. *A rick* of stove wood is usually 8′ long and 4′ high and of any length suitable for a stove.

**To find the number of cords in a pile of cordwood multiply together its length and height in feet and divide by 32.**

A ton of coal contains 25 bu. heaped (2,688 cu. in.) and measures 38 8/9 cu. ft. when mined. The number of cu. ft. per ton for coal in the mine is considerably less than after it is mined.

**To find the number of bushels of coal in a bin or wagon bed, multiply the length by the depth by the width, all in inches, and divide by 2688.**

**LIQUID MEASURE.** The liquid gallon contains 231 cu. in. This is exactly the contents of a box 3″ × 7″ × 11″ inside measurements. A cu. ft. contains 1728 cu. in. or 7 1/2 gallons of water.

**To find the number of gallons of water in a well, cistern, or other container, find the cubical contents in inches and divide by 231. If the measurements are in feet, multiply the cubical contents by 7 1/2.**

**LAND MEASURE.** In the western states land is marked out or surveyed in divisions of the form of squares or rectangles. The largest squares are laid out 24 mi. each way by north and south division lines called *meridians* and east and west lines called *base lines*. Each such 24-mi. tract is then divided into 16 squares called townships. The rows or tiers of townships lying north and south along the principal meridian are called *ranges*—the first tier west being called range No. 1 west

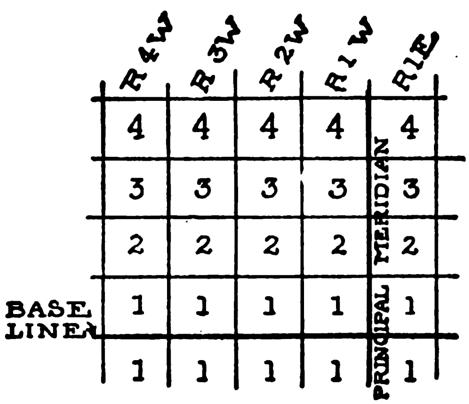



FIG. 37. A tract 24 miles square divided into 16 townships each 6 miles square according to the rectangular land survey system.

and written R1W. The townships are again subdivided into *sections*. Each section is a mile square and contains 640 acres. There may be some deviations from exactly 640 acres in a section, but these are added to or subtracted from certain half sections. This gives rise to certain fraction lines and fractional sections. (See Vol. III., p. 227, Fig. 333.)

**Rules for measuring the area of square and rectangular and odd-shaped fields are given under "Mensuration" (p. 414).**

**PAPERING AND CARPETING. To estimate the number of rolls of paper for the walls of a room, multiply the distance around the room in feet by the height in feet and divide by 72 for double rolls; and by 36 for single rolls. Deduct a double roll for each three openings. Count a fractional roll as a whole roll.**

It is necessary in carpeting a room to decide upon which way the strips are to run—lengthwise or crosswise. Allowance must be made for matching and for fractional strips since only whole strips can be bought. The width of carpets is from 3/4 yd. to a yard and that of matting 1 yard. Both are sold by the yard.

**To estimate the number of yards of carpet for a room, determine the length of the strips, then the number of them. Add to the length of each strip the allowance for waste in matching. Find in this way the combined length of the strips in feet. This divided by 3 is the number of yards required.**

## Soil Problems

**Fertilizers.** Nitrogen, phosphoric acid, and potash are the commercial plant foods contained in the soil. Different crops take different amounts of them from the soil. They may be returned to the soil by means of commercial fertilizer, straw, and manures.

A complete fertilizer (one containing all the ingredients) is quite often unnecessary, since, for example, a crop of clover may supply all the nitrogen needed for the next crop.

Commercial fertilizers must be labeled. One labeled 3-8-4 for example means (*in most states*) that it contains 3% nitrogen, 8% phosphoric acid, 4% potash.

**Drainage.** A fall of 6 in. to 1 ft. for each 100 feet is considered a good grade for farm drainage. A fall of 2 to 3 in. for each 100 feet is for most cases considered a minimum grade.

The size of the tile to be used in a main will depend upon the fall, the area to be drained, and the water from laterals.

**To determine the number of acres that a tile main of given size and grade will drain, multiply the discharge in cubic feet per second for a given size of tile on a grade of 1 ft. in a 100 ft.** (Table I) **by the square root of the grade in question from Table II, and this product by the proper constant.** This con-

stant is 24 when water to the depth of 1 in. over the area is to be removed in 24 hours: it is 48 when 1/2 in. is to be so removed and 96 if 1/4 in. is to be so removed. For open soils the 1/4 in. standard is practical.

TABLE I

| Diameter of tile in inches | Discharge in cu. ft. per sec. Grade 1 ft. in 100 ft. |
|---|---|
| 4 | 0.16 |
| 6 | 0.49 |
| 8 | 1.11 |
| 10 | 2.05 |
| 12 | 3.40 |
| 15 | 6.29 |
| 20 | 13.85 |

TABLE II

| Fall per 100 ft. | | Square Root of Grade |
|---|---|---|
| In inches | In feet | |
| 1 | 0.09 | 0.30 |
| 2 | 0.16 | 0.40 |
| 3 | 0.25 | 0.50 |
| 6 | 0.50 | 0.70 |
| 9 | 0.75 | 0.87 |
| 12 | 1.00 | 1.00 |

*Example: How many acres will a 6-in. main drain when laid on a grade of 6 ins. per 100 ft., using the half-inch standard?*

*Let $D$ = discharge of the tile (Table I)*
*$R$ = the square root of the grade (Table II)*
*$S$ = the standard constant.*
*$A$ = acres to be drained.*
*Then $A = D \times R \times S$. Substituting here the given data,*
*$A = .49 \times .70 \times 48 = 16.46$ acres = 16 to 17 acres. Answer.*

*Example: What size main should be used to drain 40 acres on a grade of 6 ins. per 100 ft., using the half-inch standard?*

*Since $A = D \times R \times S$, we have*
*$40 = D \times .7 \times 48$.*

*Therefore D, the discharge = 1.19. From Table I this discharge corresponds to about that from an 8-in. tile.*

**For average rainfall, it is usually reckoned that:**

Pipes of 3″ diam. will drain 6 acres in clay soils; 4 to 5 acres in free soils.

Pipes of 4″ diam. will drain 9 acres in clay soils; 6 to 7 acres in free soils.

Pipes of 6″ diam. will drain 25 acres in clay soils; 20 to 22 acres in free soils.

## Crops in Bulk

**CORN.** A bushel of shelled corn = 2150.4 cu. in. *On the cob* 2 1/2 cu. ft., *and in the husk* 3 1/4 cu. ft. of corn make a bushel.

**To find the number of bushels of corn in a crib, multiply the length, width, depth in feet together and divide by 3 1/4 for corn in the husk, and by 2 1/2 for corn on the cob.**

*For a round pile*, square 1/2 the distance across the pile in feet, multiply by 3 1/7, then multiply by 1/2 the height of the pile in feet and divide by 3 1/4 for corn in the husk or by 2 1/2 for corn on the cob.

*Example: How many bushels of ear corn in a wagon bed 10 ft. long, 3 ft. wide, 27 ins. or 2¼ ft. deep?*

$$\frac{10\times 3\times 2\frac{1}{4}}{2\frac{1}{2}} = \overset{2}{\cancel{10}}\times 3\times \frac{9}{\underset{2}{\cancel{4}}}\times\frac{\cancel{2}}{\cancel{5}} = 27 \text{ bu.}$$

An approximate rule, much in vogue in many communities, is to take 3 heaping half bushels of corn on the cob as the equivalent of 1 bushel of corn.

**HAY.** A ton of packed timothy hay contains about 450 cu. ft.; a ton of clover, alfalfa, or cowpea hay, about 550 cu. ft.

**To find the number of tons in a hay loft, multiply the length, width, depth in feet together and divide by 450 for timothy hay and by 550 for clover, alfalfa, or cowpea hay.**

For a mow that is shallow and recently filled, 1/8 to 1/4 should be deducted from the results of the above rule.

The only exact method of measuring hay or grain is to weigh it. The above rules, however, give practical working results.

**APPLES, POTATOES.** Apples, potatoes, turnips, etc. are measured by the *heaped* bushel. As a working rule, 1 3/5 cu. ft. may be taken as a bushel. This is slightly large. as a heaped bushel varies from 2,688 cu. in. to 2,747 cu. in. as given by different authors, and 1 3/5 cu. ft. is 2,765 cu. in.

**The number of bushels in a round pile of apples, potatoes, etc., is found as follows:** Square 1/2 the distance across the pile in feet, multiply by 3 1/7, then by 1/2 the height of the pile in feet and then by 5/8.

*Example: What is the depth of a round half bushel measure which measures 14 inches in diameter inside?*

The area of the cross section of this measure is $\left(\frac{14}{2}\right)^2 \times 3\frac{1}{7} = 154$ sq. in. The number of cu. in. in a half bushel is equal to 1075.2. This divided by 154 (*i.e.* $1075.2 \div 154$) = 7 inches deep.

A box 10 in. square and 10¾ inches deep (inside) also contains a half bushel.

## Silo, Dairy, Stock, and Meat Problems

**SILOS.** The size of a silo must be in keeping with the number of cattle to be fed. The diameter of the silo must be of such size as to insure that the proper depth will be removed

daily. Silage of all kinds deteriorates unless it is fed *regularly, evenly, and at a rate of not less than 2 inches depth daily.* Removing 5 or 6 inches depth daily insures but little waste of feed. Experience has shown that the most satisfactory results are obtained by *providing in the silo a horizontal feeding surface of about 5 square feet for each cow.*

To insure proper settling of the silage, excluding in this way the bacteria that cause decay, *the height of the silo should seldom be less than 30 feet.*

On an average, 1 ton of silage occupies about 50 cu. ft. In a small silo, 1 ton will occupy 60 cu. ft. or perhaps more.

Thus *the diameter* of a silo is controlled largely by the *number of cattle to be fed,* while *the height* is gauged by the *quantity* to be fed.

One cubic foot of silage per head is a widely used daily ration.

*Example: What should be the height of a round silo for a herd of 25 cows, if each one is to be fed 40 lbs. daily for 180 da.?*

*For 25 cows,* $5 \times 25 = 125$ *sq. ft. of horizontal feeding surface is required. This is the area of a circle. To find its diameter, divide 125 by .7854 and extract the square root of the result. This gives 12.6 ft. for the diameter of the silo.*

*But to feed 25 cows each 40 lbs. daily for 180 days requires*

$$25 \times 180 \times 40 \text{ lbs.} = 18{,}000 \text{ lbs.} = 90 \text{ tons.}$$

*Now 1 ton occupies 50 cu. ft., and 90 tons occupy 4,500 cu. ft. of space.*

*Therefore, the height of the silo is the capacity 4,500 cu. ft. divided by the cross-sectional area, 125 sq. ft., that is,*

$$\frac{4500}{125} = 36 \text{ ft., the height.}$$

**DAIRY PROBLEMS.** One gallon of milk weighs about 8 1/2 lbs. Milk from different breeds of cows will vary in the butter-fat content from 2% to 6%. One pound of butter fat is usually regarded as the equivalent of 1 1/6 lbs. of butter.

Butter fat is not only the most constant element in milk, but it has the greatest marketable value. The butter-fat content of milk is thus the basis of standardized milk.

If a certain milk is too low in butter fat, it may be brought up to the standard by adding cream or milk of a higher per cent of butter fat. Skimmilk (*but not water*) may be used to lower the per cent of butter fat.

*Example: A man has 10 gal. of 4.5% milk and 15 gal. of 2% milk. What is the per cent of milk obtained by mixing them?*

*This is merely a problem in averages* (*see the section on averages, p. 414*).

$$\frac{10 \times .045 + 15 \times .02}{10 + 5} = \frac{.45 + .30}{25} = .03, \text{ i.e. } 3\% \text{ milk.}$$

*Example: A man has 10 gals. of 4.5% milk. How many gallons of 3% milk shall he use to make 3.5% milk?*

*Let us use the formula for averaging 10 gal. of 4.5% milk and B gal. of 3% milk to get 3.5% milk. Thus*

$$\frac{10 \times .045 + B \times .03}{10 + B} = .035, \text{ i.e. } 3.5\% \text{ milk;}$$

$$\text{i.e. } 10 \times .045 + .03\,B = (.035)\ (10 + B) = .35 + .035\,B$$

$$\therefore .45 - .35 = .005\,B, \text{ from which}$$
$$.10 = .005\,B, \text{ i.e. } B = 20 \text{ gallons, the amount.}$$

**CATTLE, HOG, CALF, MEAT PROBLEMS.** Calves at birth weigh about as follows:

| | |
|---|---|
| Light-weight calves .... | 40– 60 lbs. |
| Average calves ........ | 60– 80 " |
| Heavy calves .......... | 80–110 " |

The suckling calf should gain on an average 2 lbs. per day. A calf weighing 50 lbs. at birth should weigh at the end of 90 days, $2 \times 90 + 50 = 230$ lbs. Pigs should gain about 10 lbs. for each bushel of corn fed to them. Thus corn at $1.00 per bushel should be fed to hogs that can be sold for $15.00 per hundred.

The fat calf loses 50% to 60% of its live weight when butchered, while cattle lose 40% to 50% of their live weight. Hogs lose, when butchered, 25 lbs. on the first 100 lbs., 15 lbs. on the second, and 10 lbs. on each additional 100 lbs. Country-cured meats lose one third of their weight, but in packing houses there is practically no loss in curing.

## Building Problems

**Weatherboarding.** Siding or clapboarding is dressed from wider boards. Siding 5 1/2 in. wide is dressed from a 6-in. board. A 5-in. board dresses into 4 1/2-in. siding. It is sold by the width of the board from which it is dressed. One inch is allowed for lap in weatherboarding.

**To estimate weatherboarding, find the surface in square feet to be covered; add 1/3 of this to itself, if 6-in. boards are used, and add 3/7 if 5-in. are used.** No allowance is usually made for doors and windows.

**Shingling.** Allowing for waste, it will take 1,000 shingles 4 in. wide and laid 4 in. to the weather to cover 100 sq. ft.—a so-called "square" (10 ft. each way).

A bunch of shingles contains 250 standard size shingles, taking therefore 4 bunches to a "square."

Six lbs. of nails are allowed for 1,000 shingles.

**Metal Roofing** is bought by the square.

**Flooring.** A board 2 1/2 in. wide will cover only 2 in. of floor when it is tongued and grooved; one 3 in. wide covers 2 1/2 in. but 4-in. flooring covers 3 1/4 to 3 1/2 in. of space.

**To estimate the number of feet of flooring (or ceiling) required, measure the number of square feet of surface to be covered; to this add 1/4 of itself if 2 1/2-in. flooring is used, add 1/5 of itself if 3-in. flooring is used, and 3/13 if 4-in. flooring is used.**

**Rafters.** The *rise* of a rafter is the height of its highest point above the wall plates, while the *run* is half the width of the building. The *pitch* of a roof is the *rise* of the rafters divided by the *width* of the building. A roof is 1/3 pitch if it rises 1 ft. for every 3 ft. of width of the house. A roof 1/3 pitch on a house 30 ft. wide, therefore, rises 10 ft. at its highest point.

Stonework is estimated usually per cubic yard. Brickwork is estimated by the 1,000.

**To estimate the bricks in a wall, multiply the distance around the building by its height in feet and deduct for half of the openings in square feet; multiply this result by 16 for an 8-in. wall and by 24 for a 12-in. wall.**

Bricks are usually 2" x 4" x 8" and average in weight 5 lbs. A flue for one stove is 8" x 8" in the clear and takes 6 bricks for once around and 4 rounds to build 1 ft. high; one for two stoves is 12" x 8" in the clear and takes 7 bricks for a round and 4 rounds for a foot high.

**In painting it is usual to allow 1 gal. to every 250 sq. ft. of surface.**

**Levers.** The teeter board, the common steelyard, scissors, wheelbarrow, pincers, crowbar, etc., are familiar examples of levers. The point of support is called the *fulcrum.*

Levers will balance when the weight or force on one end times its distance from the fulcrum is equal to the weight or force on the other end times its distance from the fulcrum.

*Example: A horse pulls with a force of 150 lbs. on one end of a doubletree 18" from the attaching clevis. How much does the horse pull at the other end if attached 20" from the clevis?*

*Again,* $150 \times 18 = 20 \times Force.$
*Thus,* $20 \times Force = 2700,$
$Force = 135$ *lbs.*

*Example: Where must a doubletree be attached so that a horse hitched to one end of it will pull twice as much as a colt attached at the other end?*

*Here it is necessary to divide 4 ft. or 48 ins. so that one part is twice as long as the other. This means three equal parts of 48, on one of which the horse pulls, on the other the colt. Hence ⅓ of 48 ins. = 16 ins. leaving 32 ins., the lever on which the colt pulls and 16 ins. for the horse; i.e.* $1 \times 32 = 2 \times 16$.

## Tables, Weights, Equivalents

### Long or Linear Measure

| | |
|---|---|
| 12 inches (12 in. or 12") | = 1 foot (1 ft. or 1') |
| 3 feet | = 1 yard |
| 5½ yds. or 16½ ft. | = 1 rod |
| 320 rods | = 1 mile |

1 mi. = 320 rd. = 1760 yd. = 5280 ft. = 63360 in.

### Surveyors' Measure

| | |
|---|---|
| 7.92 inches | = 1 link |
| 25 links | = 1 rod |
| 4 rods, or 100 links | = 1 chain |
| 80 chains | = 1 mi. |

Engineers generally use a steel tape 100 feet long.

### Square Measure

| | |
|---|---|
| 144 square inches | = 1 square foot |
| 9 square feet | = 1 square yard |
| 30¼ square yards<br>272¼ square feet | = 1 square rod |
| 160 square rods | = 1 acre |
| 640 acres | = 1 square mile |

### Cubic Measure

| | |
|---|---|
| 1728 cubic inches | = 1 cubic foot |
| 27 cubic feet | = 1 cubic yard |
| 128 cubic feet | = 1 cord |

### Liquid Measure

| | |
|---|---|
| 4 gills | = 1 pint |
| 2 pints | = 1 quart |
| 4 quarts | = 1 gallon |

1 gal. = 4 qt. = 8 pt. = 32 gi.

### Dry Measure

| | |
|---|---|
| 2 pints | = 1 quart |
| 8 quarts | = 1 peck |
| 4 pecks | = 1 bushel |

1 bu. = 4 pk. = 32 qt. = 64 pt.

### Avoirdupois Weight

| | |
|---|---|
| 16 ounces (oz.) | = 1 pound |
| 2000 lb. | = 1 ton |
| 2240 lb. | = 1 *long* ton |

Avoirdupois weight is used in measuring all common articles, such as coal, hay, groceries, etc.

### Troy Weight

| | |
|---|---|
| 24 grains | = 1 pennyweight |
| 20 pennyweights | = 1 ounce |
| 12 ounces | = 1 pound |

Troy weight is used in measuring gold, silver, precious stones, etc.

### Weights of Produce as used in most States

| Articles | Pounds per bushel | Articles | Pounds per bushel |
|---|---|---|---|
| Apples........ | 50 | Oats............ | 32 |
| Beans........ | 60 | Onions.......... | 57 |
| Bluegrass seed | 14 | Potatoes, Irish or white......... | 60 |
| Buckwheat... | 52 | Potatoes, sweet.. | 55 |
| Clover........ | 60 | Rye............ | 56 |
| Corn, on cob.. | 70 | Timothy seed.... | 45 |
| Corn, shelled.. | 56 | Wheat.......... | 60 |
| Flaxseed ..... | 56 | | |

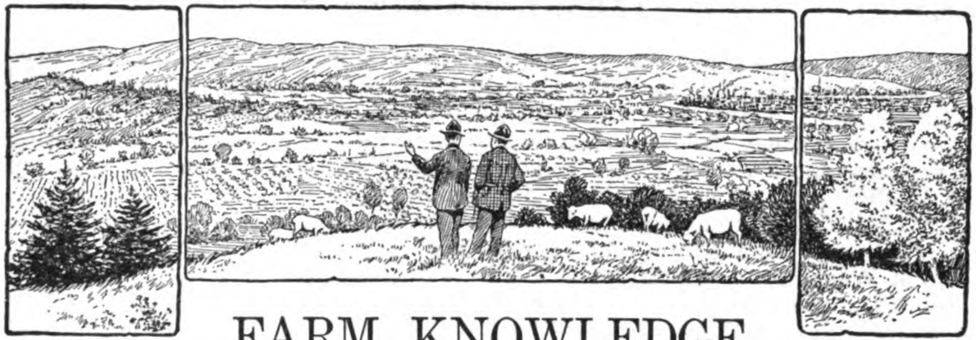
### TABLE OF EQUIVALENTS

| | | |
|---|---|---|
| 1 acre | = | 160 sq. rd. = 43,560 sq. ft. = 10 sq. chains |
| 1 are (metric measure) | = | 100 sq. meters = 120 sq. yds. = $\frac{1}{40}$ acre |
| 1 barrel | = | 31½ gallons |
| 1 barrel cement | = | 4 bags = 376 lbs. = 3.8 cu. ft. |
| 1 barrel refined oil | = | 42 gallons |
| 1 barrel flour | = | 196 lbs. |
| 1 barrel salt | = | 280 lbs. |
| 1 bushel (heaped) | = | 2,688 cu. in. to 2,747 cu. in. |

TABLE OF EQUIVALENTS—*Continued*

| | | |
|---|---|---|
| 1 bushel (stroked) | = | 2150.4 cu. in. = 1¼ cu. ft. = 35.24 liters |
| 1 bushel coal | = | 80 lbs. |
| 1 cu. centimeter | = | .0610 cu. in. = 1 gram |
| 1 cu. ft. | = | 4/5 bu. = 7½ gals. |
| 1 centimeter | = | .3937 in. = 10 millimeters |
| 1 cu. ft. cement | = | 100 lbs. |
| 1 chain (Surveyors' and Gunter's) | = | 4 rods = 66 feet = 100 links |
| 1 crown (English money) | = | 5 shillings |
| 1 cu. in. | = | 16.4 c.c. |
| 1 cubit | = | 18 inches |
| 1 degree Fahrenheit (F.) | = | F = 32° + 9/5 Centigrade (C.) |
| 1 degree of earth's circumference | = | 69.16 mi. |
| 1 dram (avoirdupois) | = | 1/16 oz. |
| 1 fathom | = | 6 feet |
| 1 foot | = | 30.48 cm. = 12 inches |
| 1 franc (French money) | = | $.193 |
| 1 furlong | = | 40 rods |
| 1 gallon | = | 3.8 liters = 231 cu. in. = 8.5 lbs. |
| 1 grain | = | .065 gram |
| 1 gram | = | 15.432 grains (avoir.) = the weight of 1 c.c. of distilled water at the temp. of melting ice. |
| 100 grams | = | 3.527 oz. (avoir.) |
| 1 guinea (English money) | = | 21 shillings |
| 1 hand | = | 4 inches |
| 1 hogshead | = | 2 bbls. = 63 gals. |
| 1 inch | = | 2.54 cm. = 25.4 mm. |
| 1 kilogram (or kilo) | = | 2.2 lbs. |
| .45 kilogram | = | 1 lb. |
| 1 kilometer | = | 1,000 meters = .62 mile |
| 1.6 kilometer | = | 1 mile |
| 1 knot* | = | 1 *nautical* mile = 1.15 mi. per. hr. |
| 1 league | = | 3 nautical miles = 3.46 miles |
| 1 link | = | 7.92 ins. = $\frac{1}{100}$ of 66 ft. |
| 1 lira (Italian money) | = | $.193 |
| 1 liter | = | 1 kilogram = 1,000 grams = 1.1 qt. liquid = .91 qt. dry |
| 1 mark (German money) | = | $.238 |
| 1 meter | = | 39.37 ins. = 3.3 ft. = 1 ten-millionth of a quadrant of earth's circum. |
| .91 meter | = | 1 yard |
| 1 mile | = | 5,280 feet = 8 furlongs = 320 rods = 1.6 kilometers |
| 1 mile (nautical) | = | 1.153 mi. = 1 minute of earth's circumference |
| 1 millimeter | = | .039 in. = $\frac{1}{10}$ cm. |
| 1 nautical mile | = | 1.153 mi. |
| 1 oz. (avoirdupois) | = | 28.35 grams |
| 3.527 oz. (avoir.) | = | 100 grams |
| 1 oz. (troy) | = | 31.1 grams |
| 1 pace | = | 3 feet |
| 1 penny (English money) | = | $.0203 |
| 1 perch, 1 pole | = | 1 rod = 16½ ft. |
| $\pi$ | = | 3.1416 |
| 1 pound (avoirdupois) | = | 7,000 grains = 16 oz. = .45 kilogram |
| 1 pound (English money) | = | $4.866 |
| 1 pound (troy) | = | 5,760 grains = 12 oz. |
| 1 quart (liquid) | = | .95 liter. |
| 1 rod | = | 1 perch or pole = 16½ ft. |
| 1 radian | = | 180 ÷ $\pi$ = 57.3° |
| 1 sq. in. | = | 6.5 sq. centimeters |
| 1 shilling (English money) | = | $.243 |
| 1 yard | = | .91 meter |

*A knot is not a *distance*, but a *rate of sailing*.



# FARM KNOWLEDGE

## PART IV

# Farming Facts and Opportunities in the United States

IN Part III of Volume II, under the title Farming Systems in the United States, there were briefly described and compared the various agricultural sections or provinces into which this country may logically be divided. As citizens and landowners, however, we are more familiar with its division into artificial or political units called states, which, for agricultural purposes of comparison, are of relatively little value. For instance, several different states, by virtue of their small size and similar locations may offer almost identical farming opportunities; whereas one other state, such as Texas or California, may include within its boundaries a range of conditions extending from subtropical to north temperate as to climate, from sea level to mountainous as to topography, and covering the whole list of staple and fancy products as far as crop raising ability is concerned.

Nevertheless, our statistics are collected by states, our laws are made largely by states, our news is distributed according to states, our commerce and means of communication are on a state basis. For these reasons the information given on the following pages has been compiled by states. In each case the matter has been prepared, after the careful consultation of authoritative descriptive data, and then submitted to state authorities for criticism, revision and correction in accordance with local or exceptional conditions. The statistics, taken in part from Census records and in part from the very latest available Department of Agriculture reports and files, provide a basis for comparison and for a tentative judgment as to possibilities. Figures for any one year or one crop cannot, of course, tell anything like a complete story; nor can yields, prices and acreages recorded for a year when war was breaking loose reflect conditions as they were, or may be once again, in times of peace. However, since all the facts are of the same date and have been collected with the same idea in mind, they show as nearly as possible a true picture of relative conditions as they have actually existed.

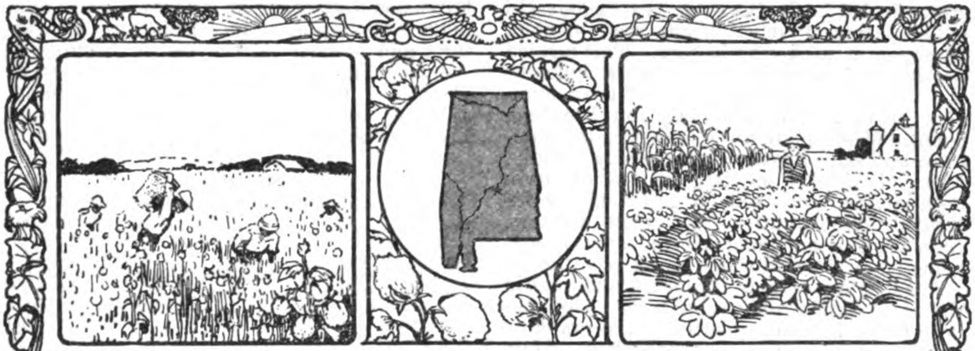
Whoever is interested in any particular state and its agricultural opportunities, should supplement the information supplied here with more detailed facts obtainable (in most cases free of charge) from various officials and departments. For example, the United States Department of Agriculture at

Washington can supply through its Bureau of Soils, Soil Maps and Surveys of many counties and smaller areas; through its Weather Bureau, the latest weather and climatic data; through its Bureau of Crop Estimates statistics as to crop acreage, yields and profits; through its Forest Service, information concerning the National Forest ranges and their use; and through its Division of Publications, various publications—including Farmers' Bulletins, Department Bulletins and circulars and reports of all kinds—many of which contain very valuable information and suggestions. The U. S. Reclamation Service, also at Washington, administers the affairs of the National Irrigation Projects and will supply prospective settlers with complete details regarding them, how to locate on them, and how best to become established. A number of the railroad systems of the country maintain colonization and agricultural departments which, rightly utilized, can be of great help. In each state there are various agencies having as either their main or subordinate aims, the distribution of information concerning their farming and industrial openings. The state departments and colleges of agriculture are among the most useful of these; their addresses are noted in the various state descriptions hereafter. When visiting a new section the farm seeker should consult also the county agent or other authorized local agricultural adviser. Finally, it should be remembered that among the best of all places to discover the real facts, are the farms of established, successful farmers, and especially their financial records for a series of years. Of course, the latter are not often available, but interested, judicious conversation usually is, and almost always is productive of helpful information and mutual advantage.

But now, to the reader, a word of caution: If times are hard, and crops and prices poor; if the neighborhood seems run down, and reports from other sections glow brightly in contrast; if taxes increase and profits diminish; if winters grow colder and summers drier and the outlook fades away into a horizon of gloom—even so, do not at once come to the conclusion that the only solution is a new location in some far distant state. Distance lends enchantment, but it may not disclose the facts; and no business more than farming thrives so well as when its roots go deep and remain undisturbed in firm, strong, well-nurtured soil. Above all, do not think of buying or in any way contracting for farm land without visiting and carefully examining it; better still, try it for a year or two—and its neighborhood as well—before locating permanently. And when, if by moving or otherwise, you do become possessed of the kind of farm that suits you, stick to it, do your best by it, and give your best to it. When you are tempted to move, think of the advice, that Abraham Lincoln gave to the friend who consulted him about such a move:

> I learned that you are anxious to sell the land where you live and move to Missouri. I cannot but think such a notion is utterly foolish. What can you do in Missouri better than here? Is the land any richer? Can you there, any more than here, raise corn and wheat and oats without work? If you intend to go to work, there is no better place than right where you are; if you do not intend to go to work, you cannot get along anywhere. Squirming and crawling from place to place can do no good. You have raised no crop this year, and what you really want is to sell the land, get the money, and spend it. Part with the land you have, and, my life upon it, you will never after own a spot big enough to bury you in.

And after reading it remember that any other state may be substituted for the one he referred to, just as the advice may just as effectively be tendered to any man, anywhere, who fails to realize that his success depends somewhat upon his surroundings, but even more upon his own knowledge, skill, adaptability and industry.—EDITOR.



# ALABAMA

**ALABAMA** ("Cotton State") is both a Gulf State and part of the Cotton Belt, being located between 30 and 35 degrees north latitude, and 84 and 88 degrees west longitude. The Chattahoochee River forms part of the eastern boundary and the Gulf of Mexico, a part of the southern boundary. With the Tennessee River crossing the northern part, the Alabama with its tributaries draining much of the western and central parts, and numerous smaller streams flowing into these and into the Gulf, the state is well watered. Mobile Bay furnishes a good harbor. Area, 52,250 square miles, of which 710 are inland waters.

**Land surface.** Four zones, or belts, cross the state from east to west. In the north, the Tennessee River Valley gives a variable surface. Next below is the diversified mineral belt, mountainous in the centre and wider and higher at the eastern than at the western boundary. South of this is the prairie or cotton belt, broadening from east to west. Below this is the timber belt, about 600 feet above sea level in the north, and sloping to tide level at the Gulf. The Alabama River and its branches drain most of the western and central portions. It then unites with the Tombigbee to form the Mobile, which flows into Mobile Bay. East of this are the Conecuh and Choctawhatchee (smaller rivers flowing across Florida into the Gulf), and the Chattahoochee along the eastern boundary. The Tennessee River drains the northern part. The Appalachian Mountains enter the state from the northeast and extend about to its centre; from here the surface slopes generally to the south and west. The highest elevation is about 2,400 feet; the general average of the highland area is about 800 feet; that of the Coastal Plain 600 feet.

**Soils.** In the northerly, Tennessee River region or grain belt, the prevailing soil is strong clay with alluvial types in the river bottoms; these are good for grain, hay and livestock. In the mineral belt, there are rich creek and river bottoms of fertile, red soils running into barren sands and sterile, rocky hillsides. The stronger soils are excellent for fruit on the uplands and for general crops and livestock on the lower levels. The cotton belt is largely made up of a dark, retentive loam. Through the timber belt, the soil is generally a light, sandy loam, usually underlaid with clay, naturally poor but susceptible of great improvement, and fine for small fruits and vegetables.

**Climate** is even, mild, and generally healthful except, perhaps (as elsewhere), in the river valleys. Killing frosts seldom occur before the winter months, and rarely last more than 48 hours. The summers are long, consistently hot, with abundant sunshine and heavy rainfall, varying from 50 inches in the northern part to more than 62 inches in some parts of the south. High winds are frequent during the winter and spring. Average annual temperatures range from 58 degrees in the northeast corner to 66 degrees at Mobile. Decatur and Maple Grove in the north, and Montgomery, have recorded 107 degrees; the lowest temperature on record is 18 degrees below zero, which occurred in the northeastern uplands. Occasional light snowstorms occur in the north. The heaviest rainfall is in winter and early spring. Winds from the Gulf temper the heat in the south.

**Products and industries.** Leading farm activities are the raising of cotton, cereals, hay and forage, potatoes and other vegetables, fruits, sugar cane and livestock. Cotton is the main money crop, exceeding in acreage and value all other farm products. Cottonseed alone exceeds in value all cereals except corn, which leads them. In 1917, Alabama grew corn on about 1,000,000 more acres than ever before. Oats are grown to some extent, with some wheat, rice, rye and Kafir corn. Fruits and nursery stock are grown increasingly, especially in the northern part. Nearly 1,000,000 acres of peanuts were

grown in 1917. In the same year, about 2½ million acres of velvet beans were planted, largely as a catch crop in corn. This has led to large increases in the livestock industry and the bringing into the state of great numbers of cattle for fattening and breeding. Swine and sheep are raised in increasing numbers, and dairying also is increasing rapidly. Many of the old-time, large plantations have been divided into smaller farms giving increased opportunities for small farmers. Lumbering is an important industry, forests being extensive and water power plentiful.

Leading minerals are iron ore and coal in the north central and central parts. Gold has been found in small quantities, and graphite, building stone and clay are abundant. Main manufactures in the order of their value are iron and steel, lumber and timber products, cotton goods, foundry and machine-shop products, railway cars, coke, flour and by-products, and cottonseed oil, cake and fertilizers. From 1915 to 1917, about 100 mills were erected in the state to prepare the velvet bean crop that is harvested. Birmingham and Montgomery are the principal manufacturing centres.

**Transportation and markets.** Principal railroads are the Southern; Louisville and Nashville; Central of Georgia; Alabama Great Southern; and Mobile and Ohio. The Mobile and Alabama Rivers and Mobile Bay furnish water communication in the south, and the Tennessee River in the north. The Chattahoochee is also navigable. Mobile is an important export centre. Many livestock marketing associations have been organized in the southern part of the state, by the Marketing Specialists of the State Extension Service. They have regular sales-days, and obtain prices considerably higher than those prevailing in unorganized communities.

**History.** Discovered by De Soto in 1540 and first settled by the French, Fort St. Louis being built in 1702. Mobile was founded in 1711, and was for several years the seat of government of the colony of Louisiana. Ceded to England in 1763; acquired by Spain in 1779; passed into hands of the United States between 1783 and 1813. Was a part, first of Georgia, then of Mississippi. Became a territory in 1817 and a slaveholding state in 1819. Seceded in 1861. Remained under military supervision until 1868. New constitutions adopted in 1875 and 1901. Capital, Montgomery (population, 1910, 38,136); largest city, Birmingham (population, 1910, 132,685); chief port, Mobile (population, 1910, 51,521).

**Agricultural organization.** A Commissioner of Agriculture at *Montgomery* is in charge of various departmental, executive and control activities, especially of fertilizers and feedstuffs. The State Agricultural College and Experiment Station and headquarters of the Extension Service are at *Auburn*. The Canebrake Sub-station is at *Uniontown;* Agricultural and Mechanical College for Negroes at *Normal;* Tuskegee Institute (for Negroes) at *Tuskegee*. There is a State Farmers' Union, a State Horticultural Society, and a State Livestock Association.

### Statistics

#### 1. Farms and Farm Property, 1920 and *1910*

Population........2,348,174; *2,138,093*
City 509,317 (21.7%); country, 1,838,857 (78.3%)
Number of farmers........256,099; *262,901*
White, 160,896 (62.4%); non-white, 95,208 (37.2%)
Land area, acres........32,818,560
Acres in farms........19,576,856; *20,732,312*
" impr. land...9,893,407 (50.5%); *9,693,581* (*46.8%*)
Average acres per farm........76; *78.9*
Farms by size:
Up to 19 acres........33,741; *41,858*
20 " 49 " ........112,848; *106,841*
50 " 99 " ........57,404; *55,448*
100 " 174 " ........32,500; *35,563*
Over 174 " ........19,606; *23,191*
Value farm property........$690,848,720; *$370,138,429*
Per cent increase in 10 years........86; *106.3*
Value of farm land........$415,763,862
" " " buildings........$216,944,175
" " " implements........$34,366,217
" " " live stock........$112,824,748
Average value all property per farm......$2,698; *$1,408*
Average value land and buildings per acre.$27.77; *$13.90*
Farms run by owners........107,089 (42%);
" " " tenants........148,269 (57.9%)
Per cent owned farms unmortgaged........60.2; *71.7*
Per cent farms reporting automobiles 6.2; telephones 15.

#### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops........$340,813,256; *$112,129,230*
Value all cereals........$82,657,266; *$30,927,210*
Corn, acres........3,334,204; *2,572,768*
(bu.)........43,699,100; *30,695,737*
10-year av. yield per acre, (bu.)........16
Wheat, acres........34,017; *13,665*
(bu.)........222,838; *113,953*
10-year av. yield per acre (bu.)........10.6
Oats, acres........85,398; *257,276*
(bu.)........1,120,384; *3,251,146*
10-year av. yield per acre, (bu.)........19.1
Cotton, acres........2,628,154; *3,730,482*
(bales)........718,163; *1,129,527*
10-year av. yield per acre (lbs.)........151
Hay and forage, acreage........705,279; *542,557*
production, (tons)........528,039
Sweet potatoes acreage........90,868; *66,613*
production (bu.)........8,095,404; *5,314,857*
Peanuts, acreage........334,239; *100,609*
production (bu.)........6,288,594; *1,573,796*
Sugar cane, acreage........25,302; *24,861*
production (tons)........208,342; *226,343*
Vegetables, total acreage......12,750; value $28,239,206
Strawberries, acreage........1,359; *1,167*
production (quarts)........2,024,051; *1,848,537*
Apples, production (bu.)........577,356; *888,396*
Pears, production (bu.)........162,509; *100,041*
Peaches, production (bu.)........1,083,142; *1,416,584*
Grapes, production (pounds)........1,446,814; *1,723,490*
Plums and prunes (bu.)........54,073; *61,712*
Forest products, value........$18,803,353; *$6,308,151*
Nurseries, acres 1,311; number 48; receipts.....$234,670
Greenhouses, sq. ft. of glass, 485,952; receipts..$264,625

#### 3. Livestock, 1920 and *1910*

Farms reporting livestock....245,574; (pure breds) 9,744
Value all livestock on farms...$112,824,748; *$65,594,834*
Horses, number........130,462; *135,636*
value........$14,448,541
Mules, number........296,138; *247,146*
value........$44,611,624
Cattle, Beef, number........322,434
all kinds, value........$32,078,763
Dairy, number........751,574
Sheep, number........81,868; *142,930*
value........$484,424

| | |
|---|---|
| Goats, number.........................104,148; *79,347* | Bees (number of hives)..............153,766; *135,140* |
| value.............................$255,468 | Milk produced (gallons)....................93,903,677 |
| Swine, number..................1,496,893; *1,266,756* | Value all dairy products........$15,299,517; *$6,396,198* |
| value............................$15,335,211 | Eggs produced (doz.)...........23,436,979; *21,945,662* |
| Poultry, number................6,266,756; *5,028,104* | Value eggs and chickens ........$14,779,501; *$6,938,916* |
| value............................$5,098,288 | Value honey and wax...............$283,148; *$99,977* |


# ARIZONA

**ARIZONA,** one of the newest states and the fifth largest, is situated in the Southwest between 31 and 37 degrees north latitude and 109 and 115 degrees west longitude. The Colorado River forms nearly the whole of the western boundary. Numerous small rivers furnish limited supplies of water for irrigation in the southern part, but those in the north are rarely available because most of them run through deep cañons. Area, 113,956 square miles.

**Land surface.** Southern and southwestern Arizona consists of broad desert plains interspersed with nearly parallel mountain ranges of considerable height. In the extreme southwest, the surface is but little above sea level. The northern part consists of tablelands. Almost the entire state is mountainous, more than two thirds of the total area having an altitude of 3,000 feet or over. The Sierra Nevada and Rocky Mountains meet in the north central part and form the rim of the Great Basin. Here are the highest elevations: San Francisco Mountain, 12,794 feet and Humphrey Peak, 12,562 feet.

**Soils.** Most of the virgin soils are lacking in humus. The state is said to be "the most arid, the most desert-like part of the United States." In the southern part, the soil is a sandy loam; on the plateaus, it is alkaline; in the river valleys it is rich and deep. Much of it is not valuable for cultivation without irrigation, but numerous irrigation projects in different parts of the state furnish water for considerable areas. With abundant water much of it is highly productive. Dry-farming is being developed in parts of the state.

**Climate.** This is widely diversified. In the north, heavy snows are frequent. In the south, a temperature of 130 degrees has been recorded, but the dryness of the air makes high temperatures seem lower than they really are. The nights are much cooler and generally comfortable. Over large parts of this area, the temperature never reaches freezing point. In the mountain districts there are great differences between day and night temperatures. Sunshine prevails during the larger part of the year. In the northern, more elevated regions, summer temperatures reach 100 degrees and more; in the desert areas and in the mountain plateaus, 85 to 95 degrees. In the Colorado Valley, 110 to 125 degrees are recorded every summer. Mountain temperatures range lower according to elevation, the lowest recorded being 24 degrees below zero at St. Michaels in February. Rainfall is very light; in the lower Colorado Valley, sometimes not more than 3 inches occurs in a year. The average is 12 inches in the Little Colorado Valley, but there is a record of 36 inches (the highest recorded) in the Grand Cañon region. Over most of the northern area, the larger part of the rainfall is in July, August and early September, with most of the remainder from November to March. Irrigation is needed over much of the state.

**Opportunities.** There are said to be 1,000,000 acres that may be irrigated when water supplies are fully conserved and developed, not half of which was irrigated in 1917. About 50 different commercial crops may be grown within the state, under irrigation, because of the great diversity of climatic conditions, ranging from temperate to subtropical. Dry-farming is in the experimental stage, but a considerable range of quick-maturing drought-

resistant crops like the sorghums, sudan grass, quick-maturing corns, beans, squashes, etc., have been developed in connection with the range industry. Opportunities exist for the development of lands with scant water supply, by methods which combine dry-farming, range livestock and a supplemental, pumped irrigation water supply. At 5,000 to 6,000 feet elevation, where rainfall is more abundant but the season short, potatoes, oats, vegetables and fruits may be grown to advantage alone or combined with livestock. Information about irrigated lands may be obtained from the U. S. Reclamation Service, Washington, D. C.; about lands in general from the State Land Commission, Phœnix.

**Products and industries.** Leading farm activities include the raising of cereals, cotton, hay, livestock, potatoes, vegetables, fruits, sugar beets and sugar cane. Barley is the leading cereal in value, followed by wheat, corn, oats and some minor grains. Alfalfa is the leading hay crop. Alfalfa seed is an important product. Potatoes and other vegetables, fruits, sorghum, beans and nursery stock are increasing in importance. The larger part are grown under irrigation. In livestock, the greatest value is in cattle with sheep next, followed by horses and mules, swine and goats. Poultry are not so important, ostriches showing the greatest value. Dairying has not been extensively followed, but is increasing. Lumbering is not as yet an important industry. In the central part is what is known as the "Mogollon Forest," covering about 10,000 square miles, said to be one of the largest timber areas in the United States. The Coconino pine forest covers 6,000 square miles. Copper is the most important mineral, representing more than four fifths of the total mineral products. Coal, gold and silver, lead, zinc, tungsten and asbestos are also found. Leading manufactured products in order of their value are smelted and refined copper, railroad-shop products, lumber and timber products, flour and grist-mill products, dairy products, manufactured ice, and bakery products.

**Transportation and markets.** Two transcontinental lines traverse the state from east to west in the southern and north central parts while several minor lines form connections north and south. Water communication is not important. The mining centers furnish excellent markets.

**History.** Extensive ruins indicate that Arizona was the home of a highly civilized race before it was first visited by white (Spanish) explorers, about 1539. Jesuits established missions among the Indian tribes in the early part of the seventeenth century, and Tucson and Tubac were founded early in the eighteenth. There was no immigration till late in the nineteenth century. Arizona was ceded by Mexico to the United States in 1848. The section south of the Gila River was acquired by the Gadsden purchase of 1854. It was separated from New Mexico in 1863, and received a territorial government. The capital was first at Prescott in 1877, but since 1889 has been at Phoenix. Arizona became a state in 1912. Population of Phoenix, 11,134; of largest city, Tucson, 13,193.

**Agricultural organization.** College of Agriculture and Experiment Station, *Tucson;* substations, *Phœnix, Tempe* and *Yuma;* Northeastern Dry Farm, *Snowflake;* Dry Farm, *Prescott;* Sulphur Spring Valley Dry Farm, *Cochise.* Cattle Growers' Association; Poultry Association; Ostrich Breeders' Association, all *Phœnix;* Wool Growers' Association, *Flagstaff;* Farm Improvement Association, *Tucson;* Commission of Agriculture and Horticulture, *Phœnix,* is especially charged with police work directed against insect pests and plant diseases within the state. Inspectors are located in all counties. The State Fair is held annually at *Phœnix.*

The Experiment Station Director reports that the tendencies and prospects of agriculture include: (1) under irrigation, the more intensive development of various agricultural specialties, such as Egyptian cotton, lettuce, alfalfa, cantaloupes, etc.; (2) the development of high-grade livestock, such as dairy cows, hogs, poultry and beef cattle; (3) in dry-farming sections, the production of silage and its feeding to cattle which are supported for a part of the year on the open range; and (4) the organization of agricultural interests by means of ditch companies, livestock, fruit-growing, shippers' and other associations. The state's agriculture is unusually diverse in character, and as yet only partly developed.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | |
|---|---|
| Population | 334,162; *204,354* |
| City | 117.527 (35.2%); *63,260 (31%)* |
| Country | 216,635 (64.8%); *141,094 (69.%)* |
| Number of farmers | 9,975; *9,227* |
| White | 9,329 (93.5%); *6,024 (65.3%)* |
| Non-white | 646 (6.5%); *3,203 (34.7%)* |
| Indian (included as non-white) | 537 |
| Land area, acres | 72,838,400 |
| Acres in farms | 5,802,126; *1,246,613* |
| Acres farm land improved | 712,803; *350,173* |
| Average acres per farm | 597.7 (71 acres improved); *135.1* |
| Acres farm land artificially drained | 9,651 (1.4% imp. land) |
| Acres farm land needing drainage | 41,951 (.7% all farm land) |
| Farms by size: | |
| Up to 19 acres | 1,436; *3,346* |
| 20 " 49 " | 2,367; *1,477* |
| 50 " 99 " | 1,703; *820* |
| 100 " 174 " | 2,239; *2,591* |
| 175 " 499 " | 1,351; *757* |
| Over 500 " | 879; *236* |
| Value all farm property | $233,592,989; *$75,123,970* |
| Per cent increase in 10 years | 210 |
| Value farm land | $156,562,606; *$42,349,737* |
| " " buildings | 15,762,715; *4,935,573* |
| " " implements | 8,820,667; *1,787,790* |
| " " livestock | 52,447,001; *26,050,870* |
| Av. value all property per farm | $23,418; *$8,142* |
| Av. value land and buildings per acre | $29.70; *$37.93* |
| Number farms run by owners | 7,869 (*79.%*); *8,302* (*89.%*) |

Number farms run by tenants 1,801 (18.1%); *861 (9.3%)*
Per cent owned farms unmortgaged........ 3,708 (47.1%); *7,038 (85.8%)*
Per cent farms reporting automobiles 45.5; telephones 16.4

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value, all farm crops | $42,481,230; | *$5,434,664* |
| " all cereals | 5,464,931; | *1,570,853* |
| Corn, acres | 22,150; | *15,605* |
| (bu.) | 446,208; | *298,664* |
| 10-yr. av. yield per acre | 29.9 bu. | |
| Wheat, acres | 37,131; | *20,028* |
| (bu.) | 835,374; | *362,875* |
| 10-yr. av. yield per acre | 27.7 bu. | |
| Oats, acres | 11,862; | *5,867* |
| (bu.) | 377,785; | *189,312* |
| 10-yr. av. yield per acre | 40.1 bu. | |
| Barley, acres | 21,748; | *32,897* |
| (bu.) | 656,835; | *1,008,442* |
| 10-yr. av. yield per acre | 36.2 bu. | |
| Cotton, acres | 106,283; | *19* |
| bales | 59,359; | *11* |
| 10-yr. av. yield per acre | 264 lbs. | |
| Hay and forage, acres | 197,498; | *494,686* |
| tons | 480,463 | |
| value | $10,658,211; | *$2,564,156* |
| Potatoes, white, acres | 2,505; | *1,151* |
| (bu.) | 174,301; | *97,141* |
| sweet, acres | 317; | *200* |
| (bu.) | 34,474; | *21,206* |
| Strawberries, acres | 20; | *58* |
| quarts | 17,058; | *95,247* |
| Vegetables, acres | 6,062; value $1,794.699 | |
| Apples (bu.) | 120,765; | *72,814* |
| Peaches (bu.) | 138,361; | *50,102* |
| Pears (bu.) | 18,201; | *13,289* |
| Grapes (lbs.) | 669,673; | *837,842* |
| Plums and prunes (bu.) | 23,786; | *8,420* |
| Forest products, value | $67,754; | *$45,312* |
| Nurseries, acres | 60 in 14 establishments | |
| receipts | $23,481 | |
| Greenhouses, | sq. ft. under glass, 6,516 | |
| receipts | $4,343 | |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| No. farms reporting livestock | 9,355 (pure breds 1,069) | |
| Value all livestock on farms | $52,447,001; | *$24,376,530* |
| Horses, number | 136,167; | *99,578* |
| value | $5,744,671; | *$4,209,726* |
| Mules, number | 11,982; | *3,963* |
| value | $1,415,397; | *$399,449* |
| Cattle, all, number | 821,918; | *824,929* |
| value | $35,500,759; | *$14,624,708* |
| Beef, number | 768,197 | |
| Dairy, number | 53,721; | *28,862* |
| Sheep, number | 881,914; | *1,226,733* |
| value | $7,123,719; | *$4,400,514* |
| Goats, number | 161,124; | *246,617* |
| value | $861,793; | *$555,327* |
| Swine, number | 49,599; | *17,208* |
| value | $885,590; | *$113,714* |
| Poultry, number | 517,312; | *268,762* |
| value | $640,595; | *$1,545,966* |
| Bees, no. of hives | 28,174; | *23,770* |
| Livestock products, value | $6,294,886; | *$2,769,881* |
| All dairy products, value | $2,745,329; | *$909,411* |
| Milk produced (gallons) | 14,370,833; | *6,881,608* |
| Eggs produced (doz.) | 2,524,832; | *1,731,872* |
| Value eggs and chickens | $2,102,831; | *$1,051,348* |
| " wool and mohair | $11,632,517; | *$1,046,881* |
| " honey and wax | $217,976; | *$57,203* |

**4. Irrigation, 1920 and *1910***

| | | |
|---|---|---|
| Acres in farms | 5,802,126; | *1,246,613* |
| Acres irrigated | 467,565; | *320,051* |
| Per cent increase | 46.1 | |
| Acres included in enterprises | 813,153; | *944,090* |
| Acres irrigable by enterprises | 627,303; | *387,655* |
| Acres irrigated reported open for settlement | 24,341 | |
| Capital invested in irrigation | $33,498,094; | *$17,677,966* |
| " " per acre (av.) | $53.40; | *$45.60* |
| Estimated final cost | $34,615,064; | *$24,828,868* |
| Average cost per acre | $42.57; | *$26.30* |
| " " operation and maintenance per acre | $3.27; | *$0.93* |
| Acreage crops grown under irrigation (1909) | 333,616 | |
| Value crops grown under irrigation (1909) | $34,190,780 | |
| Value crops grown under irrigation per acre | $102.49 | |


**ARKANSAS** ("Bear State"), one of the Cotton Belt States, is situated between 33 and 37 degrees north latitude and 89 and 95 degrees west longitude. The eastern boundary is the Mississippi River, into which runs the Arkansas which divides the State in a northwest and southeast direction. Area, 53,335 square miles, 810 of which are water.

**Land surface.** The eastern border and southeastern corner are low and subject to overflow by the Mississippi. From here the land rises gradually, giving a rolling surface across the center of the State from northeast to southwest, and a hilly and mountainous section in the northwest where the Ozark Mountains begin. The White River drains

the northeastern section, and the Ouachita, Saline, and Bartholomew Rivers the southern part. The highest point is Magazine Mountain in the northwestern part, 2,833 feet. About 40,000 square miles are forested, much of this being in the uplands.

**Soils.** The soils of the uplands are usually light, including the silt loams, with some heavier clays. The lowlands show heavier and richer soils, especially along the river valleys.

**Climate.** This is generally mild and healthful. Temperatures range from 20 degrees below zero, the lowest recorded, to 112 degrees above, but over much of the state zero weather is rare. Average temperature for spring is 61; for summer, 79; for autumn, 62; for winter, 41.5. The frost-free season varies from 192 to 237 days. The average annual rainfall is about 48 inches. There is no lack of moisture, but snow is not common, except in the mountains. Destructive storms, except occasional hail storms and summer thunder showers, are rare.

**Opportunities.** About one tenth of one per cent of the farms (all in the southern part) are irrigated, chiefly for rice. There are large areas of swamp land, much of which can be made into the best of agricultural land by drainage.

**Products and industries.** Leading farm activities are the growing of corn, rice, cotton, hay and forage, potatoes and fruits; livestock, poultry and dairy cattle; small fruits and orchard products. Of orchard fruits, apples furnish more than half the value, peaches and nectarines most of the remainder. The small fruits are mostly strawberries. The production of livestock and dairying have increased rapidly. In order of value, mules lead with horses next, cattle, swine, poultry and sheep following. Lumbering is carried on extensively, the value of the products being considerable. The leading mineral is coal. Bauxite, zinc, lead and fullers' earth are of lesser value. Manufactures are favored by abundant bituminous coal and lumber, and there is a large output of timber products, more than all other manufactures together. Others in order of importance are oil, cottonseed and cake; flour and grist-mill products; railroad-shop construction; carriages and wagons; bakery products; foundry and machine-shop products.

**Transportation and markets.** Except in the north and west central sections, railroad facilities are well supplied. The Mississippi River on the east is an important factor in water communication, and the Arkansas and its tributaries through a large part of the central part. The Arkansas is navigable for about 650 miles. Leading market cities are Little Rock, Fort Smith, Pine Bluff, Hot Springs.

**History.** First settled in 1686. Bought from France; part of Louisiana territory until 1812, and of Missouri territory till 1819; became a State in 1836; readmitted into the Union in 1868. Capital, Little Rock; population, 1910, 45,491; also the largest city.

**Agricultural organization.** College of Agriculture and Experiment Station, *Fayetteville*; State Agricultural Schools, *Russellville, Jonesboro, Magnolia, Monticello;* Coöperative Demonstration Work, *Little Rock;* Horticultural Society, Farmers' Union, State Fair Association.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population........................1,752,204; *1,574,449*
City ..........290,497 (16.6%); *202,681 (12.9%)*
Country....1,461,707 (83.4%); *1,371,768 (87.1%)*
Number of farmers..................232,604; *214,678*
White........160,322 (68.9%); *151,085 (70.3%)*
Non-white.......72,282 (31.1%); *63,593 (29.6%)*
Land area, acres.........................33,616,000
Acres in farms.................17,456,750; *17,416,075*
Acres farm land improved.......9,210,556 (52.8%); *8,076,254 (46.4%)*
Average acres per farm.......145 (75.4 acres improved)
Farm land artificially drained, acres.........415,293 (42.% improved land)
Farm land needing drainage, acres.........1,610,656 (8.2% all farm land)
Farms by size:
Up to 19 acres..................35,943; *36,259*
20 " 49 " ....................92,438; *74,983*
50 " 99 " ....................50,619; *45,373*
100 " 174 " ....................36,275; *39,353*
175 " 499 " ....................15,732; *17,149*
Over 500 " ....................1,597; *1,561*
Value all farm property......$924,395,483; *$400,089,303*
Per cent increase in 10 years.......................131
Value of farm land......................$607,773,440
" " " buildings.....................$145,337,226
" " " implements.................$43,432,237
" " " live stock.....................$127,852,580
Average value all property per farm......$3,974; *$1,864*
Average value land and buildings per acre $43.14; *$17.75*
Number farms run by owners...... 112,647 (48.5%); *106,649 (49.8%)*
Number farms run by tenants...... 119,221 (51.3%); *107,266 (50.0%)*
Per cent owned farms unmortgaged..........57.6; *77.2*
Per cent farms reporting automobiles 6.6; telephones 22.7

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops........$340,813,256; *$112,129,230*
Value all cereals............ 86,996,422; *32,262,922*
Corn, acres.............. 2,292,119; *2,277,116*
bushels.............. 34,226,935; *37,609,544*
10-year av. yield per acre (bu.)..............19.7
Wheat, acres............ 256,211; *60,426*
bushels.............. 205,405; *526,414*
10-year av. yield per acre (bu.)..............11.4
Oats, acres.............. 173,317; *197,449*
bushels.............. 2,703,753; *3,212,891*
10-year av. yield per acre (bu.)..............23.9
Cotton, acres............ 2,553,811; *2,153,222*
bales................ 869,350; *776,879*
10-year av. yield per acre (lbs.)..............185
Hay and forage, acreage.....................1,002,333
production (tons).......................989,780
value................$22,760,223; *$4,985,308*
Potatoes, acreage...................39,019; *22,388*
production (bu.)............3,959,870; *1,685,305*
Potatoes, white acreage............ 24,128; *29,719*
production (bu.).1,765,277; *2,096,793*
Peanuts, acreage.......................21,962; *10,192*
production (bu.).............308,676; *168,608*
Sorghum, acreage.......................41,424; *27,532*
production (tons).............120,416; *83,041*
Rice, acreage..........................143,211; *27,419*
production (bu.)..........6,797,126; *1,282,830*
Vegetables, total acreage......18,985; value $23,635,595
Strawberries, acreage..........................8,324; *7,361*
production (quarts)......11,463,971; *8,259,240*
Apples, production (bu.)...........7,163,619; *2,296,043*

| | |
|---|---|
| Peaches, production (bu.) | 3,340,823; *1,901,647* |
| Pears, production (bu.) | 123,605; *37,547* |
| Grapes, production (pounds) | 2,444,598; 2,593,727 |
| Plums and prunes, production (bu.) | 161,906; *194,649* |
| Forest products, value | $13,805,907; *$6,914,262* |
| Nurseries, acreage 757 in 59 establishments; receipts | $185,860 |
| Greenhouses, sq. ft. under glass, 352,904; receipts | $197,829 |

**3. Livestock, 1920 and *1910***

No. farms reporting livestock 214,163 (pure breds, 15,475)

| | |
|---|---|
| Value all livestock on farms | $127,852,580; *$74,058,292* |
| Horses, number | 251,926; *254,716* |
| value | $24,151,061; *$23,152,209* |
| Mules, number | 322,677; *222,200* |
| value | $47,751,655; *$27,128,027* |
| Cattle all, number | 1,072,966; *1,028,071* |
| value | $35,023,854; *$15,460,666* |
| Beef, number | 345,806 |
| Dairy, number | 727,160; *425,793* |
| Sheep, number | 100,159; *144,189* |
| value | $827,294; *$327,984* |
| Swine, number | 1,378,091; *1,518,947* |
| value | $12,809,913; *$5,170,924* |
| Poultry, number | 7,395,654; *5,788,570* |
| value | $6,143,635; *$2,063,432* |
| Bees, number of hives | 112,475; *92,731* |
| Milk produced, gallons | 87,623,651; *83,081,875* |
| Value all dairy products | $13,445,124; *$6,587128* |
| Eggs produced, doz. | 28,168,285; *26,486,526* |
| Value eggs and chickens | $16,245,102; *$7,327,834* |
| Value wool and mohair produced | $191,607; *$87,561* |
| Value honey and wax produced | $202,117; *$112,968* |

# CALIFORNIA

**CALIFORNIA** ("Golden State"), the largest of the Pacific Coast group, and second largest state in the Union, is situated between 32 and 42 degrees north latitude, and 116 and 125 degrees west longitude. The Colorado River is on the southeast, and on the west the Pacific Ocean. Area 158,360 square miles, of which 2,188 are water.

**Land surface.** The state is largely mountainous, two great ranges, the Sierra Nevada in the eastern part, and the Coast Range in the western, extending through the State from northwest to southeast. Between these lie the two Great Valleys which are like a long, narrow dish, some 500 miles from north to south and 50 miles across, with a break about halfway down the western rim where the drainage system of the valleys runs into San Francisco Bay. This system consists of the Sacramento River from the north through the Sacramento Valley and the San Joaquin from the south through the San Joaquin Valley. The Sierra Nevada range averages about 80 miles in width, and includes Mt. Whitney (more than 14,500 ft.), the highest peak in the United States outside of Alaska. Several other peaks exceed 14,000 feet, and those above 10,000 feet are numerous. In the southeast beyond the mountain ranges, is a sunken arid region containing Death Valley and the Mohave and Colorado deserts, much of which is below sea level. Besides the Great Valleys, there are many smaller valleys, plateaus and tablelands giving great variety to the state as to surface, scenery, climate, soils, crop adaptation and agriculture. Yosemite Valley is world-famed for its scenic beauty.

**Soils.** These are characterized by their great depth. In the interior valleys, they are largely rich, sandy loams; gravelly and lighter sandy loams are found in the more arid regions. Clay loam soils and adobes occur extensively in the central part of the Sacramento Valley and to a great extent around San Francisco Bay. Typical alluvial lands are found in the lower river bottoms. In a considerable area along the foothills of the eastern border of the Sacramento and San Joaquin Valleys, the soil is for the most part a reddish clay loam underlaid with hardpan 2 to 4 feet from the surface. Sandy soils in California that can be irrigated produce some remarkable crops and are well adapted to general farming.

**Climate.** The climate shows great diversity, but in general might be classified as temperate or mild. Snow is found on the highest mountain peaks at all times, and some of the northern mountainous areas have severe winters. In the great interior valleys, the winter, spring and fall are mild and temperate. The summers might be considered warm, but the

heat is of a dry nature, and is not so severe as would be indicated by the thermometers. The central and south coast section has a uniform and delightful climate the year 'round, with rarely, if ever, freezing temperatures. In the Colorado Desert, highest recorded temperature is 126 degrees in the shade, the highest for the United States also. The average annual temperatures are at Los Angeles and San Diego 60 degrees, San Francisco 55 degrees, Bakersfield 65 degrees, Shasta 52 degrees, Sacramento 59 degrees, and Crescent City 51 degrees. The rainfall, climatic and soil conditions are so diversified that general statements have little if any value. In the Great Interior Valley, Palo Verde and Imperial Valleys the rainfall is greatest in the northern part of the Sacramento Valley, the average being about 30 inches. This gradually diminishes further south until the average rainfall is only about 10 inches in the southern portion of the San Joaquin Valley. Imperial and Palo Verde Valleys have practically no rainfall, depending entirely upon irrigation water from the Colorado River. The climate is mild or temperate. On the floor of these valleys, there is some frost during the winter months, but the growing season extends over about 9 or 10 months of the year. The north-coast area receives the greatest rainfall of any portion of the state, the average being about 60 inches per year. In the central-coast area, the rainfall is variable, ranging from 30 inches to 10 inches annually, the average being about 22 inches. The climate is mild and temperate practically the year around, although there is a little frost occasionally during the winter. In the south-coast area, the rainfall averages about 16 inches. Irrigation is not extensively practised in this locality except in the orchards. The climate is temperate the year around. Rarely, if ever, are freezing temperatures felt.

**Opportunities.** The diversity of soil, water and climatic conditions offers facilities for the successful cultivation of almost every field, garden, or orchard crop known to temperate or sub-tropical regions. Additional irrigation water is constantly being developed in the great interior valleys and, to a limited extent, in some of the desert areas, thus bringing additional lands under intensive cultivation which always affords an opportunity for new settlers. The Agricultural Experiment Station, at Berkeley, will advise settlers regarding farming opportunities, and assist them in selecting land adapted to the particular kind of farming that they desire to follow.

**Products and industries.** Agricultural products far exceed the products of the mines. All the cereals are raised, but fruit growing is the leading farm industry, and livestock is raised extensively. Dairy and poultry products should receive special mention. Sugar beets are an important product. Lumbering is a very important industry. California is celebrated for its forests and the size of its trees, the largest in the world. Fisheries are valuable, salmon leading. Mining was formerly the principal industry with gold, silver, quicksilver, copper, petroleum, salt and borax the leading minerals. Main manufactures are sugar refining; meat packing; lumber and timber products; flouring; canning and evaporation of fruits and vegetables; and machine-shop products. Leading manufacturing centers are San Francisco, Los Angeles, Oakland, Sacramento, San José, Stockton, and Fresno.

**Transportation and markets.** California is well covered by railroads. Foreign commerce is extensive to Alaska, Hawaii, Asiatic countries, Australia and other islands of the Pacific, San Francisco being the leading port; Los Angeles, San Diego, and Eureka are other important seaports and markets.

**History.** Explored along the Coast by several voyagers during the sixteenth century. San Diego occupied by Spanish missionaries in 1769; San Francisco in 1776; Los Angeles in 1781. California passed under Mexican control in 1822. Became a sovereign state 1836–1845, though having a federal union with Mexico. A revolt led to its being declared a territory of the United States in 1846. Gold, discovered in 1848, led to a large immigration. Adopted a constitution prohibiting slavery in 1849 and was admitted as a State following year.

**Agricultural organization.** The California Fruit Exchange is the largest coöperating agricultural organization in America. Other large and similar organizations are the Associated Raisin Growers, *Fresno;* Peach Growers' Association, *Fresno;* the Prune and Apricot Growers' Association, *San José;* Bean Growers' Association, *Oxnard;* Poultry Producers' Association, *Los Angeles* and *Petaluma,* Associated Milk Producers, *San Francisco;* Sacramento Valley Dairymen's Association, *Sacramento.* State Board of Agriculture holds and conducts the State Fair at *Sacramento,* and gathers agricultural statistics; Fish and Game Commission, *Sacramento,* State Dairy Bureau, *San Francisco;* State Veterinarian, *Sacramento;* State Commission of Horticulture, *Sacramento.* The Agricultural Experiment Station is a part of the University of California, at *Berkeley,* and has farm bureau organizations in most of the agricultural counties of the state. The Grange and Farmers' Union also have organizations in this state.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

Population......................3,426,861; *2,377,549*
  City:....2,331,729 (68%); *1,469,739 (61.8%)*
  Country. 1,095,132 (32.0%); *907,810 (38.2%)*
Number of farmers...................117,670; *88,197*
  White.....111,184 (94.5%); *147,123 (96.5%)*
  Non-white......6,486 (5.5%); *3,078 (3.5%)*
  Chinese and Japanese...............5,618

| | | |
|---|---|---|
| Land area, acres | 99,617,280 | |
| Acres in farms | 29,365,667; | *27,931,444* |
| Acres farm land improved | 11,878,339; | *11,389,894* |
| Average acres per farm | 249.5 (100.9 imp.); | *316.7* (*40.8* imp.) |
| Farm land artificially drained. | 813,960 acres (6.9% imp. farm land) | |
| Farm land needing drainage. | 286,320 acres (1.0% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 34,067; | *22,525* |
| 20 " 49 " | 31,723; | *20,614* |
| 50 " 99 " | 15,034; | *10,680* |
| 100 " 174 " | 13,217; | *12,015* |
| 175 " 499 " | 13,671; | *12,551* |
| Over 500 " | 9,958; | *9,812* |
| Value all farm property | $3,431,021,861; | *$1,614,694,584* |
| Per cent. increase in ten years | 112; | *102.7* |
| Value farm land | $2,783,054,977; | *$1,317,195,448* |
| " " buildings | $290,756,132; | *$133,406,040* |
| " " implements | $136,069,290; | *$36,493,158* |
| " " livestock | $221,141,462; | *$127,599,938* |
| Av. value all property per farm | $29,158; | *$18,308* |
| " " land and buildings per acre | $104.67; | *$51.93* |
| Number farms run by owners | 87,580 (74%); | *66,632* (*75%*) |
| Number farms run by tenants | 25,141 (21.4%); | *18,148* (*20.6%*) |
| Per cent owned farms unmortgaged | 41.2; | *59.1* |
| Per cent farms reporting automobiles 53.1; telephones 31.7 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $589,757,377; | *$146,526,151* |
| " " cereals | $108,570,469; | *$28,039,826* |
| Corn, acres | 116,740; | *51,935* |
| production (bu.) | 3,448,459; | *1,273,901* |
| 10-yr. av. yield per acre | 35. bu. | |
| Wheat, acres | 1,086,428; | *478,217* |
| production (bu.) | 16,866,882; | *6,203,206* |
| 10-yr. av. yield per acre | 16.3 bu. | |
| Oats, acres | 146,889; | *192,158* |
| production (bu.) | 2,966,776; | *4,143,688* |
| 10-yr. av. yield per acre | 33.3 bu. | |
| Rye, acres | 18,396; | *7,027* |
| production (bu.) | 185,820; | *70.683* |
| Cotton, acres | 87,308; | *329* |
| production (bales) | 46,418; | *183* |
| 10-yr. av. yield per acre | 364 lbs. | |
| Hay and forage, acres | 2,202,853 | |
| production (tons) | 4,494,940 | |
| value | $96,121,846; | *$42,206,252* |
| Potatoes, white, acres | 63,305; | *67,688* |
| production (bu.) | 8,217,937; | *9,824,005* |
| 10-yr. av. yield per acre | 135 bu. | |
| sweet, acres | 7,632; | *5,111* |
| production (bu.) | 867,300; | *572,814* |
| 10-yr. av. yield per acre | 153 bu. | |
| Peanuts, acres | 516; | *99* |
| production (bu.) | 16,946; | *2,991* |
| Sugar beets, acres | 88,257; | *78,671* |
| production (tons) | 666,866; | *843,269* |
| Hops, acres 12,000; production (lbs.) | 21,000,000 | |
| Barley, acres | 987,068; | *1,195,158* |
| production (bu.) | 21,897,283; | *26,441,954* |
| 10-yr. av. yield per acre | 27.9 bu. | |
| Rice, acres | 130,367 | |
| production (bu.) | 6,926,313; | |
| Small fruits, acres | 7,936; | *9,687* |
| production (quarts) | 15,458,726; | *26,824,120* |
| Strawberries, acres | 4,974; | *4,585* |
| production (quarts) | 10,808,048; | *15,694,326* |
| Oranges, production (boxes) 15,075,000; value $41,456,000 | | |
| Vegetables, acres 146,242; value | $47,377,921; | *$12,121,958* |
| Apples, production (bu.) | 7,842,017; | *4,935,073* |
| Pears, production (bu.) | 3,952,923; | *1,928,097* |
| Peaches, production (bu.) | 15,969,073; | *9,267,118* |
| Plums and prunes (bu.) | 13,200,805; | *9,317,979* |
| Grapes, production (lbs.) | 2,055,644,612; | *1,673,686,525* |
| Forest products, value | $4,248,661; | *$2,949,732* |
| Nurseries: acres 4,080 in 540 establishments; receipts | $2,929,458 | |
| Greenhouses: sq. ft. under glass 5,063,298; receipts | $2,177,371 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 99,661; pure breds 9,506 | |
| Value all livestock on farms | $221,141,462; | *$127,599,938* |
| Horses, number | 402,407; | *468,886* |
| value | $35,416,507; | *$47,099,196* |
| Mules, number | 63,419; | *69,761* |
| value | $7,221,930; | *$9,016,444* |
| All cattle, number | 2,008,037; | *2,007,025* |
| value | $120,681,446; | *$52,785,068* |
| Beef cattle, number | 1,229,086 | |
| Dairy cattle, number | 778,951; | *467,332* |
| Sheep, number | 2,400,151; | *2,417,477* |
| value | $25,906,445; | *$8,348,997* |
| Goats, number | 115,759; | *138,413* |
| value | $1,130,035; | *$320,829* |
| Swine, number | 909,272; | *766,551* |
| value | $13,850,907; | *$5,108,803* |
| Poultry, number | 10,811,183; | *6,087,267* |
| value | $15,293,570; | *$3,844,526* |
| Bees, number of hives | 180,719; | *201,023* |
| Livestock products, value | $103,932,013; | *$38,277,320* |
| Value all dairy products | $55,642,649; | *$20,543,977* |
| " eggs and chickens | $40,341,744; | *$14,683,209* |
| " wool and mohair | $6,805,621; | *$2,484,767* |
| " honey and wax | $1,141,999; | *$665,367* |
| Milk produced (gallons) | 276,424,216; | *154,901,956* |
| Butter made (lbs.) | 5,757,759; | *15,301,871* |
| Eggs produced (dozens) | 64,123,885; | *40,735,238* |

### 4. Irrigation, 1920 and *1910*

| | | |
|---|---|---|
| Acres in irrigation projects | 7,805,207; | *5,490,360* |
| " of projects irrigable | 5,894,466; | *3,619,378* |
| " " " irrigated | 4,219,040; | *2,664,104* |
| " " irrigated land open to settlement | 533,981 | |
| Capital invested in projects | $194,886,388; | *$72,580,030* |
| Investment per acre | $33.06; | *$20.05* |
| Estimated final cost | $225,799,123; | *$84,392,344* |
| Av. cost per acre | $28.93; | *$15.37* |
| Av. cost maintenance and operation, per acre | $4.40; | *$1.54* |
| Acreage crops on irrigated land (1919) | 2,329,052 | |
| Value crops on irrigated land (1919) | $319,208,503 | |
| Av. value crop on irrigated land, per acre | $137.06 | |

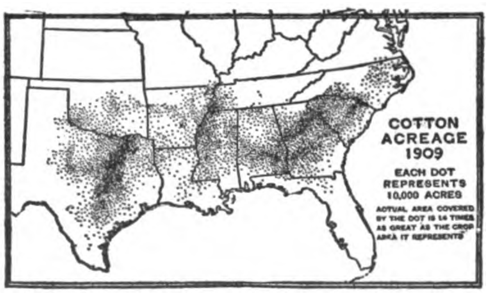
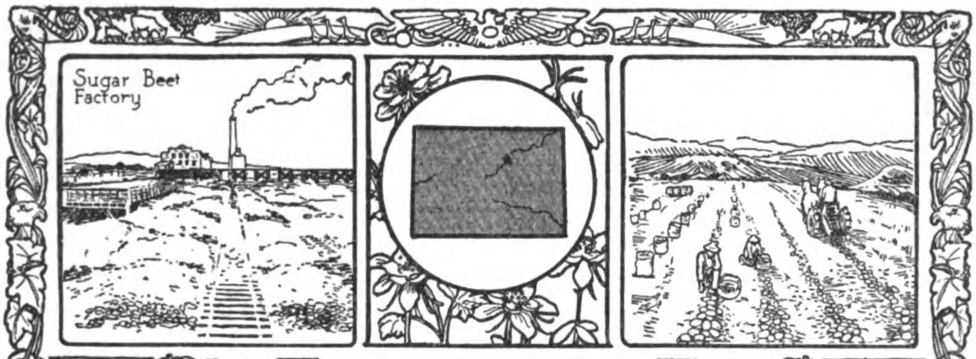



**FIG. 371. Climatic conditions set the limits of the cotton belt. Increased production in the future depends on soil fertility, improved methods, and heavier yielding strains.**




# COLORADO

**COLORADO** ("Centennial State"), one of the Rocky Mountain States, is situated between 37 and 41 degrees north latitude, and 102 and 109 degrees west longitude. Area 103,925 square miles, 280 of which are water.

**Land surface** is divided into three natural sections. The great Rocky Mountain Front Range extends north and south across the state about in the center, and the western part is made up of mountain ranges and includes "parks." East of the mountains, the foothills occupy a narrow belt across the state, while the plains occupy the eastern third of the state, with an average elevation of about 4,500 feet, the lowest on the east being about 3,000 feet. More than 200 mountain peaks reach an elevation of nearly 13,000 feet, and more than 25 more than 14,000 feet. The "parks" are high inclosed valleys or plateaus between the mountain ranges of the western half, important among which are: North, South, Middle and San Luis Parks. They occupy from 2,000 to 8,000 square miles each, and the first 3 have an elevation of 8,000 feet. The Colorado River system, through the Grand River, drains the western third, the Platte and Arkansas of the Mississippi system, the eastern part. The Rio Grande originating in Southern Colorado is noted for its gorges and cañons.

**Soils.** Only about one third of the state is agricultural land. The soils are largely alluvial and respond readily to irrigation, which is necessary on the larger part.

**Climate** is notably healthful. Chief features are low humidity; abundant sunshine; light rainfall in the plains regions, 14 to 18 inches, the heaviest except on high mountains, mostly early in the growing seasons; moderately high winds; higher rainfall and snowfall in the high mountain regions, and extreme variations in temperature according to elevation. Number of rainy days, lowest 41 at Rockyford; highest, 121 at Climax. Average annual snowfall, highest, 367.4 inches at Climax; lowest, 11.2 at Delta. Average annual rainfall in agricultural section about 18 inches; highest 54.2 inches, Climax; lowest, 16.89, average at Cañon City about 12 inches. Latest spring killing frost, June 26, near Long's Peak; earliest killing fall frost, September 2, near Long's Peak; latest, October 18, Grand Junction. Highest temperature recorded at Lamar and Delta, 109 degrees in July and August, lowest, 47 degrees below zero at Lay, in February and December. The range is great because of the wide difference in elevation. The higher, the colder and the greater the rain and snowfall. Sudden and severe changes of temperature are rare.

**Opportunities.** The arid soil requires irrigation. About 55 per cent of all farms are irrigated, a larger area than in any other state. Smaller farms are the rule in irrigated areas, hence Colorado should furnish opportunities for the small farmer. Merchants and bankers in the cities have combined to aid farmers who lack capital to purchase sufficient seed and equipment in order to increase the production of foodstuffs. Co-operation between farmers and business men is a great help toward larger production. There are usually lands for sale on the irrigation projects, and information about them may be secured from the Reclamation Service, Department of the Interior, Washington, D. C.

**Products and industries.** Colorado is largely a state of special crops and special industries, developed in particular, specially-adapted localities. Potatoes are the staple in the Greeley and other districts, cantaloupes about Rockyford, fruit growing on the western slopes, and alfalfa, livestock and grain in a number of different parts. Sugar beets are an important crop, and new factories are being built. Seed growing is an important industry, the climate being specially favorable to the development and maturity of

many kinds of plants. In Colorado are one of the largest seed firms, and one of the most extensive seed-cleaning plants in the West. Cattle, horses, sheep, mules and swine are important, in order named. Many silos are being erected. Lumbering is unimportant. Leading minerals are gold, silver, lead, copper, coal and spelter. Colorado is among the first of the states in mining. Main manufactures are grist-mill products, railway cars, foundry and machine-shop products, meat products, beet sugar and canned goods. Water power is abundant, favoring manufacturing industries.

**Transportation and markets.** Except in the mountainous regions, railway facilities are well supplied. The mining towns and cities furnish excellent markets. There are numerous marketing associations for the different products; grain elevators, sugar-beet factories, creameries and other buildings for taking care of the products are being erected.

**History.** Visited by American explorers as early as 1806. Belonged to Mexico till the war of 1846. Successful gold prospecting led to considerable immigration in 1858. Territory organized in 1861; admitted as state in 1876. Capital and largest city, Denver, population (1910) 213,381. Leading cities, Pueblo, 44,395; Colorado Springs, 20,078.

**Agricultural organization.** State Agricultural College and Experiment Station; Extension Service and Coöperative Demonstration Work, all *Fort Collins*. Potato Growers' Association, *Montrose*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population....939,629; *799,024*
City....453,259 (48.2%); *404,840 (50.7%)*
Country 486,370 (51.8%); *394,184 (49.3%)*
Number of farmers....59,934; *46,170*
White....59,381 (99.1%); *45,596 (98.8%)*
Non-white....553 (.9%); *574 (1.2%)*
Land area, acres....66,341,120
Acres in farms....24,462,014; *13,532,113*
Acres farm land improved....7,744,757; *4,302,101*
Average acres per farm.... 408 (129 improved); *293 (93 impr.)*
Farm land artificially drained.. 127,037 (1.6% impr. farm land)
Farm land needing drainage.... 270,997 (1.1% all farm land)
Farms by size, number:
Up to 19 acres.... 4,932; *5,070*
20 " 49 " .... 4,449; *3,882*
50 " 99 " .... 5,913; *4,384*
100 " 174 " ....12,139; *16,355*
175 " 499 " ....21,611; *12,476*
Over 500 " ....10,890; *4,003*
Value all farm property....$1,076,794,749; *$491,471,806*
Per cent increase in 10 years....$119; *203.2*
Value farm land.... $763,722,716; *$362,822,205*
" " buildings.... 102,290,944; *45,696,656*
" " implements.... 49,804,509; *12,791,601*
" " livestock.... 160,976,580; *70,161,344*
Av. value all property per farm....$17,966; *$10,654*
" " land and buildings per acre....$36.40; *$30.19*
Number farms run by owners.... 45,291 (75.6%); *36,993 (81.2%)*
Number farms run by tenants.... 13,763 (23.%); *8,390 (18.2%)*
Per cent owned farms unmortgaged....46.3; *72.5*
Per cent farms reporting automobiles 47.3; telephones 36.7

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

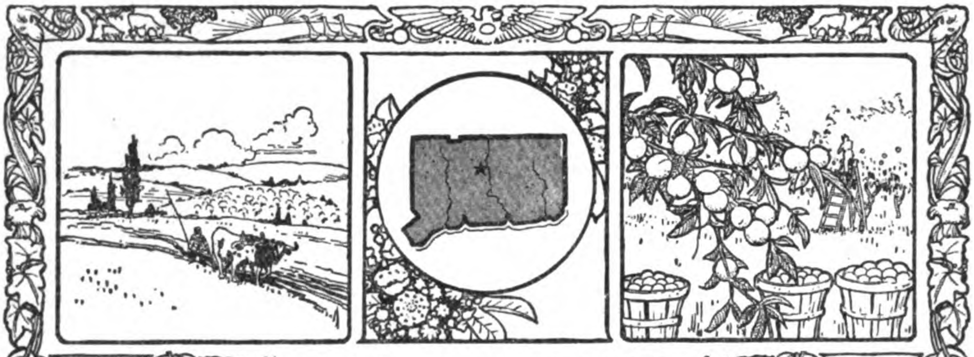
Value all farm crops....$181,065,239; *$60,110,677*
" " cereals.... $63,380,214; *$14,787.519*
Corn, acres.... 752,637; *326,559*
production (bu.).... 10,106,627; *4,903,304*
10-yr. av. yield per acre....18.7 bu.
Wheat, acres.... 1,328,616; *340,729*
production (bu.).... 18,260,663; *7,224,057*
10-yr. av. yield per acre....19.7 bu.
Oats, acres.... 174,189; *275,948*
production (bu.).... 4,535,527; *7,642,855*
10-yr. av. yield per acre....35.1 bu.
Rye, acres.... 133,131; *15,715*
production (bu.).... 1,088,564; *198,026*
10-yr. av. yield per acre....14.1 bu.
Barley, acres.... 153,015; *71,411*
production (bu.).... 2,801,498; *1,889,342*
10-yr. av. yield per acre....30.2 bu.
Hay and forage, acres....2,215,730
production (tons)....3,580,123
value.... $60,769,080; *$17,327,615*
Potatoes, white, acres.... 77,337; *85,839*
production (bu.).... 8,874,783; *11,780,674*
10-yr. av. yield per acre....12.2 bu.
sweet, acres.... 334; *21*
production (bu.).... 4,621; *2,827*
Peanuts, acres.... 516; *99*
production (bu.).... 16,946; *2,991*
Sugar Beets, acres.... 165,840; *108,005*
production (tons).... 1,658,167; *1,230,718*
Small fruits, acres.... 1,798; *2,829*
production (quarts).... 2,213,619; *4,294,988*
Strawberries, acres.... 653; *1,326*
production (quarts).. 944,276; *1,674,923*
Vegetables, acres 18,438; value $24,804,225; *$6,058,939*
Apples, production (bu.).... 3,417,682; *3,529,094*
Pears, production (bu.).... 269,465; *132,536*
Peaches, production (bu.).... 721,480; *692,258*
Plums and prunes (bu.).... 44,944; *81,539*
Grapes, production (lbs.).... 526,509; *1,037,614*
Forest products, value.... $563,476; *$305,719*
Nurseries, acres 159 in 33 establishments; receipts $83,062
Greenhouses: sq. ft. under glass 1,982,534;
receipts....$1,062,264

### 3. Livestock, 1920 and *1910*

Number farms reporting livestock 59,938; pure breds 8,781
Value all livestock on farms....$160,976,580; *$70,161,344*
Horses, number.... 420,704; *294,035*
value.... $31,816,018; *$27,382,926*
Mules, number.... 31,125; *14,739*
value.... $3,384,824; *$1,798,535*
All cattle, number.... 1,756,616; *1,127,737*
value.... $94,929,748; *$31,017,303*
Beef cattle, number....1,434,423
Dairy cattle, number.... 322,193; *144,734*
Sheep, number.... 1,813,255; *1,426,214*
value....$19,355,618; *$6,856,187*
Goats, number.... 28,688; *31,611*
value.... $164,924; *$801.644*
Swine, number.... 449,866; *179,294*
value.... $7,802,084; *$1,568,158*
Poultry, number.... 2,994,347; *1,721,445*
value.... $2,924,006; *$1,012,251*
Bees, number of hives.... 63,253; *71,404*
Livestock products, value.... $26,921,292; *$9,705,676*
Value all dairy products.... $12,674,036; *$4,174,270*
" eggs and chickens.... $8,773,648; *$3,837,045*
" wool and mohair.... $4,888,684; *$1,460,027*
" honey and wax.... $584,924; *$234,334*
Milk produced (gallons).... 79,492,631; *33,651,723*
Butter made (lbs.).... 5,775,602; *5,856,132*
Eggs produced (dozens).... 14,172,375; *10,577,829*

### 4. Irrigation, 1920 and *1910*

Acres in irrigation projects....5,220,588; *5,917,457*
" of projects irrigable....3,855,348; *3,990,160*
" " " irrigated....3,348,385; *2,792,032*
" " irrigated land open to settlement....274,282
Capital invested in projects....$88,302,442; *$56,636,443*
Investment per acre....$22.90; *$14.19*
Estimated final cost....$5,198,423; *$76,443,239*
Av. cost per acre....$18.24; *$12.92*
" " maintenance and operation, per acre .$.87; *$.75*
Acreage crops on irrigated land (1919)....$1,946,676
Value crops on irrigated land (1919).... $100,215,136
Av. value crops on irrigated land per acre....$51.48



# CONNECTICUT

**CONNECTICUT** ("Nutmeg State"), one of the 13 original colonies, and the southernmost New England State, is situated between 40 and 43 degrees north latitude, and 71 and 74 degrees west longitude. Area, 4,965 square miles, of which 145 are water surface.

**Land surface.** Several ranges of hills traverse the state from north to south, with river valleys between. The highest elevations are in the northern part, Bear Mountain (2,355 feet) and Gridley Mountain (2,200 feet). These elevations are southern extensions of the Green Mountains, the Mount Tom Range and the Blue Hills. Three large rivers cross the state from north to south, the Housatonic, the Connecticut and the Thames and its branches. The Connecticut River, the largest in New England, drains an area of more than 11,000 square miles and its valley is the chief agricultural district of the state. Long Island Sound forms the southern boundary; the general slope is from its shore northward, and from the rivers to the dividing elevations.

**Soils.** Those of the valleys, especially of the Connecticut, are very fertile, largely alluvial silt, or sandy loam. The lighter soils are along the Sound shore. On the higher elevations, the soil is heavier, more or less mixed with clay, and very rocky. The soils vary so much over small areas that it is hard to classify them more definitely.

**Climate** is temperate, though the weather is likely to be very changeable. Average annual temperature is about 50 degrees; average for winter 27 degrees, for summer, 72 degrees. Highest recorded temperature, 103 degrees at Middletown in July; lowest, 25 degrees below zero at North Grosvenor Dale in January. Earliest killing frost occurred September 19, at Hartford and Middletown; latest killing frost occurred May 17 at New Haven. Average annual snowfall ranges from 40.3 inches at New Haven to 75.8 at Cream Hill. Average annual rainfall is about 50 inches, pretty well distributed throughout the year. Fogs sometimes prevail along the shore.

**Opportunities.** "Abandoned" or, more accurately, "run-down" farms are less numerous than formerly. The more elevated and rocky parts of the country are specially well fitted for the dairy industry, whose products are in great demand in city markets, both in and outside the state. The lower foothills are admirably adapted for the growing of tree and small fruits and grapes. The river valleys are excellent for market gardening and special crops requiring rich soils. Poultry raising finds good conditions in the mild climate and light soils. Information about available agricultural lands may be obtained from the Agricultural Experiment Station at Storrs.

**Products and industries.** Leading farm activities are dairying and livestock raising, fruit and tobacco growing, truck farming and some other special lines. Dairying is the most important farm industry, milk for city trade being in great demand. Sheep are receiving more attention, as are swine. Horses are a valuable product. Poultry is important. Corn and potatoes lead as farm crops. Tobacco is a leading money crop in certain specially adapted soils of the Connecticut Valley; the product of this section equals that of any other part of the world. Onion growing is carried on extensively in the river valleys, as well as the production of most other vegetables. Seed-growing is important. Tree and small fruits of most kinds are largely grown, apples, and peaches leading the former, strawberries the latter. Great advances have been made in recent years. Fisheries along the Sound are a source of much profit, Connecticut leading the states in value of oysters. Mining is unimportant, though iron, granite, lime and feldspar are found. Connecticut is a leading manufacturing state, producing mainly brass and bronze; foundry and machine-shop products; cotton goods; silks; firearms and ammunition; woolen, worsted and

felt goods, and wool hats; silver and plated wares; corsets; automobiles; cutlery and tools. Chief manufacturing centers are New Haven, Bridgeport, Hartford, Waterbury, Meriden, Stamford, New London, Torrington, Manchester and Danbury.

**Transportation and markets.** Railroad transportation over most of the state is furnished mostly by the New York, New Haven, and Hartford Railroad. There is a large mileage of electric railways, many of which carry freight and express. Water transportation by way of Long Island Sound is important. The Connecticut River is navigable to Hartford, and, by small vessels, beyond the borders of the state. Excellent markets for choice products are found in the great cities of New York and Boston and every manufacturing city and town in the state is a good, safe home market.

**History.** Dutch settlers from New Netherlands established a trading post at Hartford in 1633. First English settlements by colonists from Massachusetts in 1634 at Wethersfield, 1635 at Windsor and Hartford. Many immigrants from Massachusetts in 1636-1637. Declared itself free and independent state in 1776. Not in sympathy with War of 1812. In the Civil War Connecticut furnished a large quota of troops for Federal service.

**Agricultural organization.** Agricultural College and Experiment Station, *Storrs*. A second Experiment Station at *New Haven*. Coöperative Demonstration Work, *Storrs*. State Board of Agriculture, Pomological Society, Alfalfa Growers' Association of Connecticut, Beekeepers' Association, Dairymen's Association, Poultry Association, Sheep Breeders' Association, Vegetable Growers' Association, New England Tobacco Growers' Association, Horticultural Society, State Agricultural Society, State Grange, Nurserymen's Association.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 1,380,631; *1,114,756* |
| City | 936,339 (67.8%); *731,797 (65.6%)* |
| Country | 444,292 (32.2%); *382,959 (34.4%)* |
| Number of farms | 22,655; *26,815* |
| White | 22,580 (99.7%); *26,702 (99.6%)* |
| Non-white | 75 (.3%); *113 (.4%)* |
| Land area, acres | 3,084,800 |
| Acres in farms | 1,898,980; *2,185,788* |
| Acres farm land improved | 701,086; *988,252* |
| Average acres per farm | 83.8 (30.9 acres improved) |
| Farm land artificially drained | 14,646 (2.1% improved land) |
| Farm land needing drainage | 56,462 (3% all farm land) |
| Farms by size: | |
| Up to 19 acres | 4,673; *6,035* |
| 20 " 49 " | 5,535; *6,306* |
| 50 " 99 " | 5,807; *6,634* |
| 100 " 174 " | 4,199; *4,999* |
| 175 " 499 " | 2,233; *2,613* |
| Over 500 " | 208; *228* |
| Value all farm property | $226,991,617; *$159,399,771* |
| Per cent increase in 10 years | 42.2; *40.7* |
| Value farm land | $101,187,115; *$72,206,058* |
| " " buildings | $89,083,712; *$66,113,163* |
| " " implements | $13,248,097; *$6,916,648* |
| " " livestock | $23,472,693; *$14,163,902* |
| Av. value all property per farm | $10,019; *$5,944* |
| " " land and buildings per acre | $100.20; *$63.28* |
| Number farms run by owners | 19,666 (86.7%); *23,234 (86.5%)* |
| Number farms run by tenants | 1,919 (8.5%); *2,632 (9.8%)* |
| Per cent owned farms unmortgaged | 9,597 (48.8%); *13,080 (56.3%)* |
| Per cent farms reporting automobiles 30; telephones 51.8 | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | |
|---|---|
| Value, all farm crops | $44,472,644; *$19,279,953* |
| " all cereals | $4,457,809; *$2,039,211* |
| Corn, acres | 42,486; *52,717* |
| (bu) | 2,062,495; *2,530,542* |
| 10-yr. av. yield per acre | 47.5 bu. |
| Wheat, acres | 2,776; *616* |
| (bu) | 50,102; *11,869* |
| Oats, acres | 10,889; *10,207* |
| (bu) | 295,050; *273,804* |
| 10-yr. av. yield per acre | 31.8 bu. |
| Rye, acres | 5,445; *7,601* |
| (bu) | 83,979; *137,692* |
| 10-yr. av. yield per acre | 19.8 bu. |
| Hay and forage acres | 354,150 |
| (tons) | 664,773 |
| value | $13,711,567; *$7,225,543* |
| Potatoes, white, acres | 18,300; *23,958* |
| (bu) | 1,372,449; *2,684,414* |
| sweet, acres | 9; *41* |
| (bu) | 316; *4,133* |
| Buckwheat, acres | 1,768; *2,797* |
| (bu) | 25,509; *51,751* |
| 10-yr. av. yield per acre | 18.7 bu. |
| Maple sugar, trees tapped | 9,023; *12,296* |
| sugar made (lbs) | 5,173; *10,207* |
| syrup made (gals) | 2,866; *4,236* |
| Strawberries, acres | 636; *993* |
| (quarts) | 1,239,553; *3,016,295* |
| Vegetables, acres | 9,120; value $17,218,194 |
| Apples (bu) | 1,395,141; *1,540,996* |
| Peaches (bu) | 194,990; *269,990* |
| Pears (bu) | 57,162; *41,322* |
| Grapes (lbs) | 2,109,885; *1,317,682* |
| Plums and prunes (bu) | 3,687; *13,663* |
| Forest products, value | $2,753,292; *$1,861,853* |
| Nurseries, acres 543, in 55 establishments; receipts | $1,039,439 |
| Greenhouses, sq. ft. under glass | 3,504,179 |
| receipts | $2,166,829 |

### 3. Livestock, 1920 and *1910*

| | |
|---|---|
| No. farms reporting livestock | 20,511 (pure breds 2,149) |
| Value all livestock on farms | $23,472,693; *$14,163,902* |
| Horses, number | 38,125; *46,341* |
| value | $5,303,426; *$5,739,000* |
| Mules, number | 869; *416* |
| value | $136,423; *$72,721* |
| Cattle, all, number | 173,764; *195,318* |
| value | $14,400,427; *$6,730,287* |
| Beef, number | 11,025 |
| Dairy, number | 162,739; *122,853* |
| Sheep, number | 10,842; *22,418* |
| value | $155,101; *$112,349* |
| Goats, number | 447; *500* |
| value | $5,912; *$2,785* |
| Swine, number | 61,071; *52,372* |
| value | $1,434,231; *$472,741* |
| Poultry, number | 1,153,667; *1,265,702* |
| value | $1,979,099 |
| Bees, no. of hives | 6,960; *9,445* |
| Livestock products, all, value | $20,862,330; *$11,564,736* |
| All dairy products, value | $14,923,971; *$7,669,183* |
| Milk produced (gallons) | 54,894,287; *45,749,849* |
| Eggs produced (doz) | 6,341,424; *8,497,812* |
| Value eggs and chickens | $5,876,684; *$3,850,879* |
| " wool and mohair | $31,256; *$18,761* |
| " honey and wax | $30,419; *$25,913* |


# DELAWARE

**DELAWARE** ("Blue Hen State") is one of the North Atlantic States, situated between 38 and 40 degrees north latitude, and 75 and 76 degrees west longitude. It is the second smallest of the states, having an area of 2,050 square miles, of which 90 square miles are water.

**Land surface.** Most of the state is nearly level and belongs to the Atlantic Coastal Plain. A central sandy ridge nowhere more than 70 feet high extends north and south, dividing the drainage basins of the Chesapeake and Delaware Bays. Numerous small streams flow into these. The highest point, 280 feet above tide water, is in the north where are some rolling and hilly lands. There are marshy areas and shallow bays along the coast.

**Soils.** In the north are some heavy clays and clay loams. A belt of loam follows the shores of Delaware Bay. Through the center, sandy and silt loams prevail. In the south, sandy soil predominates with underlying clay which often approaches the surface, producing clay loam. Some reclaimed swamps supply a rich alluvial soil.

**Climate** is mild, generally healthful. The average annual temperature at Dover is 54.7 degrees. The highest temperature recorded is 104 degrees at Milford, in July, and the lowest 12 degrees below zero at the same place in January. Average date of first killing frost in autumn is October 17, at Milford, earliest date being October 2. Average date of latest killing frost in spring is April 23 at Millsboro, latest being May 12 at Newark and Seaford. The average annual rainfall is from 40 to 50 inches, well distributed through the year so that harmful droughts are rare. Snowfall is light, 24 inches being the highest recorded figure for any year.

**Opportunities.** Delaware is distinctly agricultural. Its mild climate, long growing season, fertile soil, frequent and abundant rains, adapt it to a large variety of crops and fruits. Its location within easy shipping distance of large cities on either side, render marketing easy. There is no public land except some sand dunes in Sussex County.

**Products and industries.** The leading industry is fruit growing, apples being the main tree fruit, especially in the central part. Pears, peaches, plums and grapes are largely grown. Strawberries are the leading small fruit, and immense quantities are produced. Truck farming is an important industry. Dairying is extensive in the north, and poultry raising throughout the state. Fisheries are important, shad and trout leading. Minerals are unimportant. Manufacturing enterprises turn out leather, cars, ships, foundry and machine-shop products, paper and wood pulp, flour, and canned vegetables and fruits. The last mentioned industry is very important. Wilmington is the chief manufacturing city (population in 1910, 87,411, in 1917, 106,000.)

**Transportation and markets.** Railroad facilities are good. Electric railways are improving what is sometimes criticised as too little railroad competition. There are many miles of state roads in New Castle County. One of the public-spirited citizens has already built a boulevard through most of Sussex County, and has offered to build a road to connect it with the northern part of the state, the specifications of which are to be prescribed by the State Highway Commission. Wilmington is the only seaport, and aside from this, water transportation is confined mostly to vessels of light draft, running to nearby towns by way of Delaware and Chesapeake Bays. The chief markets are the large cities of nearby states, Philadelphia; Jersey City, Newark, New Jersey; Pittsburg, Chester, Pa.; New York, New Haven, Boston, Buffalo. By means of refrigerator cars, most markets within 1,000 to 1,500 miles are reached with perishable products.

**History.** Colony founded by the Dutch in 1631, on Lewis Creek, was destroyed by Indians. Swedish settlement made in 1638 near present site of Wilmington. From 1640 to 1656 incessant warfare between Swedes and Dutch, the latter finally winning. From 1664, except one brief period, under English control till the Revolutionary War. Ceded to Wm. Penn in 1683, and considered part of Pennsylvania till 1703, when it was allowed a separate legislature. Separate state government established in 1776. First state to ratify the U. S. Constitution, December 7, 1787. Slave-holding state; sentiment divided during Civil War, but supported Union Cause.

Agricultural organization. State Board of Agriculture is located at *Dover*. State Fair is held at *Wilmington*. Agricultural College and Experiment Station are located at *Newark*. State College for colored students at *Dover*.

The Director of the State Experiment Stations reports that Delaware is entering upon a new era, not only in industry but also in agriculture and in education. The world demand for powder has materially increased the importance of the state, and it is quite probable that the demand for dyes and other pigments that formerly came from Europe will soon be supplied by the manufacturing companies of this state. The ship builders of Delaware are adding to their facilities in order to help meet the call for more ocean-going vessels, a demand that will take many years to supply.

On account of great markets close at hand, there has been a marked tendency for the agriculture of Delaware to take the direction of intensive crops, such as tree fruits (especially apples), berries, tomatoes, sweet and round potatoes, cantaloupes, watermelons, early cabbage, and asparagus. The war shortened the labor supply to such an extent that many farmers are giving up trucking crops, and growing more wheat and corn.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 223,003; | *202,322* |
| City | 120,767 (54.2%); | *97,085 (48%)* |
| Country | 102,236 (45.8%); | *105,237 (52%)* |
| Number of farmers | 10,140; | *10,836* |
| White | 9,268 (91.4%); | *9,914 (91.5%)* |
| Non-white | 872 (8.6%); | *922 (8.5%)* |
| Land area, acres | 1,257,600 | |
| Acres in farms | 944,511; | *1,038,866* |
| Acres farm land improved | 653,052; | *713,538* |
| Average acres per farm | 93.1 (64.4 a. improved); | *95 (65 a. impr.)* |
| Farm land artificially drained | 185,831 a. (28.5% impr. farm land) | |
| Farm land needing drainage | 68,969 a. (.2% farm land) | |
| Farms by size: | | |
| Up to 19 acres | 1,226; | *1,535* |
| 20 " 49 " | 2,182; | *1,988* |
| 50 " 99 " | 2,952; | *2,977* |
| 100 " 174 " | 2,510; | *2,849* |
| 175 " 499 " | 1,218; | *1,529* |
| Over 500 " | 52; | *58* |
| Value all farm property | $80,137,614; | *$63,179,201* |
| Per cent increase in 10 years | 26; | *5.52* |
| Value farm land | $42,115,802; | *$34,938,161* |
| " " buildings | $22,639,829; | *$18,217,822* |
| " " implements | $6,781,318; | *$3,206,095* |
| " " livestock | $8,600,665; | *$6,817,123* |
| Av. value all property per farm | $7,903; | *$5,830* |
| Av. value land and buildings per acre | $68.56; | *$51.17* |
| Number farms run by owners | 6,010 (59.3%); | *6,178 (57%)* |
| Number farms run by tenants | 3,986 (39.3%); | 4,535 (41.9%) |
| Per cent owned farms unmortgaged | 58.3; | *61.8* |
| Per cent farms reporting automobiles | 36.4 | |
| Per cent farms reporting telephones | 2.72 | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value, all farm crops | $2 ,058,906; | *$8,650,192* |
| " all cereals | $9,638,010; | *$ 4,692,329* |
| Corn, acres | 170,612; | *188,755* |
| (bu) | 3,686,109; | *4,839,548* |
| 10-yr. av. yield per acre | 33.4 bu. | |
| Wheat, acres | 125,740; | *111,215* |
| (bu) | 1,571,567; | *1,643,572* |
| 10-yr. av. yield per acre | 15.8 bu. | |
| Oats, acres | 4,736; | *4,226* |
| (bu) | 70,791; | *98,239* |
| 10-yr. av. yield per acre | 30.4 bu. | |
| Rye, acres | 6,198; | *1,017* |
| (bu) | 58,235; | *11,423* |
| 10-yr. av. yield per acre | 15 bu. | |
| Hay and forage, acres | 201,365 | |
| (tons) | 223,562 | |
| value | $4,366,174; | *$1,174,695* |
| Potatoes, white, acres | 8,255; | *9,703* |
| (bu) | 487,668; | *880,360* |
| sweet, acres | 9,813; | 5,229 |
| (bu) | 1,505,278; | *733,746* |
| Buckwheat, acres | 9,443; | *4,002* |
| (bu) | 75,059; | *53,903* |
| 10-yr. av. yield per acre | 18.5 bu. | |
| Small fruits, acres | 3,915; | *8,687* |
| (quarts) | 4,362,473; | *14,425,209* |
| Strawberries, acres | 3,503; | *7,194* |
| (quarts) | 4,046,028; | *12,730,265* |
| Vegetables, acres | 33,360; value $6,271,714 | |
| Apples (bu) | 606,286; | *183,094* |
| Peaches (bu) | 227,375; | *16,722* |
| Pears (bu) | 97,703; | *105,357* |
| Grapes (lbs) | 1,445,121; | *1,938,267* |
| Plums and prunes (bu) | 1,613; | *657* |
| Forest products, value | $777,176; | *$346,062* |
| Nurseries, acres, 189, in 20 establishments; receipts | $56,089 | |
| Greenhouses, sq. ft. under glass | 241,251 | |
| receipts | $111,608 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| No. farms reporting livestock | 9,816 (pure breds 637) | |
| Value all livestock on farms | $8,600,665; | *$6,817,123* |
| Horses, number | 27,752; | *33,065* |
| value | $2,172,609; | *$3,451,791* |
| Mules, number | 9,439; | *5,935* |
| value | $1,161,877; | *$764,133* |
| Cattle, all, number | 46,509; | *54,986* |
| value | $3,394,160; | *$1,648,333* |
| Beef, number | 1,752 | |
| Dairy, number | 44,757; | *35,708* |
| Sheep, number | 3,220; | *7,806* |
| value | $38,397; | *$36,898* |
| Goats, number | 91; | *88* |
| value | $574 | |
| Swine, number | 38,621; | *49,260* |
| value | $603,323; | *$337,91* |
| Poultry, number | 1,000,287; | *876,081* |
| value | $1,215,586; | *$560,146* |
| Bees, no. of hives | 2,976; | *6,410* |
| Livestock products, all, value | $5,778,747; | *$2,910,412* |
| Value all dairy products | $2,553,175; | *$1,089,497* |
| " eggs and chickens | $3,210,151; | *$1,807,503* |
| " wool and mohair | $8,949; | *$5,1 77* |
| " honey and wax | $6,466; | *$8,235* |
| Milk produced (gallons) | 11,356,313; | *7,859,757* |
| Eggs produced (dozens) | 3,908,463; | *4,395,100* |

# FLORIDA

**FLORIDA** ("Peninsular State"), most southerly of the United States, between 24 and 31 degrees north latitude, and 79 and 88 degrees west longitude. Area 58,666 square miles, of which 3,805 are water surface.

**Land surface.** Generally level except in the northwestern part which is somewhat hilly, but no elevations exceed 350 feet. The highlands of Georgia and Alabama extend into the State. A central axis of about 350 feet elevation runs through the peninsula north and south, somewhat east of the middle portion, making the watershed most largely towards the Gulf of Mexico with a gradual slope from sea level up to the center axis on both sides, also from the Gulf north along the western portion. The larger portion of the state is less than 100 feet above sea level. The waters of the Suwanee, which empty into the Gulf of Mexico, and the waters of the St. Mary's, which empty into the Atlantic Ocean, at places come from the same lake. These two rivers form a natural depression separating the highlands of central and south Florida from the highlands of Georgia. The St. Johns River is navigable for nearly 250 miles, and is the only river in the United States of considerable size which flows northward. Some 1,200 to 1,400 lakes have been listed and named. Lake Okeechobee is the largest of the fresh-water lakes, and among the largest fresh-water lakes occurring wholly within the United States; its elevation is about 22 feet above sea level.

Formerly the Everglades extended northward to the latitude of Tampa; by drainage more than a million acres of the northern portion were made fit for grazing purposes nearly 30 years ago.

**Soils.** The larger portion of the surface of Florida is covered with sand, stiff clay occurring in east and west Florida and occasionally in peninsular Florida. Among the best lands in the state are those that are covered with a gray sandy soil with a slight admixture of clay. These soils occur either in west Florida or throughout the peninsula, usually at the higher elevations. Hardwood areas, when occurring on the sandy regions along the coast and throughout peninsular Florida, are spoken of as hammock lands. The essential difference between hammock soils and pine-wood soils is that fires, which have swept over the pine-woods lands for countless ages, have been barred by the hammocks, allowing a natural accumulation of organic matter in these regions.

**Climate.** The lowest temperature in the last 50 years was 3 degrees below zero in the western part. In extreme south Florida, the temperature rarely goes below 32 degrees, and frosts are frequently absent for the entire year. The heaviest rainfalls occur during the summer months, May, June, July and August. The average rainfall is about 50 inches; during some years, this may reach 75 inches, and during dry years as low as 35 inches. West Indian hurricanes sometimes pass over the state; their violence is not equal to that of a cyclone, but the area covered is much more extensive. The loss of human life is a very unusual occurrence in these hurricanes. Cyclones are practically unknown.

**Opportunities.** The state is draining the Everglades at an expense of about $6,000,000. Nearly all the drained lands will produce large quantities of forage and other farm crops. Truck growing is carried on where transportation is available. Some of these lands have been much misrepresented, and no one should buy these or other lands without seeing them. Good opportunities also exist on the higher lands. Over a large part of the state, flowing artesian wells may be obtained which furnish abundant water at a nominal cost. A few homesteads are still vacant, whose location may be ascertained at the U. S. Land Office, Gainesville. They are mostly located at considerable distances

from transportation facilities. State lands occur in a number of different places and a large body of the drained land is owned by the state. Information may be obtained from the Commissioner of Agriculture, Tallahassee. The state owns more than 1,000,000 acres, some of which may be purchased in farm size at reasonable prices. The draining of the Everglades is carried on by the Board of Internal Improvements, from whom information may be obtained at Tallahassee. The fine winter climate attracts many winter visitors to the state, and these help to furnish local markets for all kinds of agricultural products.

**Products and industries.** The leading crop is citrus fruits, the principal attention being devoted to grapefruit and oranges. Corn leads the farm crops; velvet beans, sweet potatoes, cotton and peanuts are important crops. Tobacco of the finest grade is produced in considerable quantity. Strawberries are grown largely, especially for mid-winter and early spring delivery. Pineapples are grown extensively along the east coast. Tropical fruits, of which the avocado is taking the lead, are produced in the extreme southern portion. Livestock raising, especially the production of cattle on large ranges, is important. Hog raising is growing rapidly. Lumbering, turpentining and rosin production have been carried on largely in the virgin forests. The state still contains a large area suitable for this work. The fisheries are among the most important industries in the state. Florida ranks fifth in the United states in its output. Sponge fishing is an important and leading line. Oysters are shipped in large quantities. The only mineral of great importance in the state is rock phosphate, of which Florida furnishes about three fourths of the American output.

**Transportation and markets.** Railroads are found in all parts of the state, no county being without them. The numerous deep lakes and deep rivers furnish ample waterways for transportation in all parts of the state. Foreign and coastwise shipping is an important adjunct. The extensive coast line gives many fine shipping ports. The principal ports are Jacksonville, Tampa, Pensacola and Key West.

**History.** Ponce de Leon landed on the shores of Florida in 1513, and took possession for the King of Spain. Other Spanish explorers made attempts at settlement during the next 50 years, but with little success because of the hostility of the natives. 1763, ceded by Spain to Great Britain, returned to Spain in 1783. Sold by Spain to United States in 1819, organized into a territory 1819, admitted as State 1845. Seceded in 1861, adopted new Constitution and readmitted to Union 1868.

**Agricultural organization.** The Commissioner of Agriculture, located at *Tallahassee*, has charge of the enforcement of fertilizer, feed and pure-food laws, the sale of state lands and numerous other duties in connection with the agriculture of the state. The State Plant Board has its official offices on the campus of the University at *Gainesville*, Its duty is to prevent the introduction and dissemination of noxious insects and plant diseases, as well as to control and eradicate those already in the state. The State Livestock Sanitary Board has its central offices at *Tallahassee*, the Commissioner of Agriculture being Chairman of the Board. Its duty is to prevent the introduction and dissemination of diseases among livestock, as well as to control or eradicate such disease already in the state. The State Agricultural College and Experiment Station are located on the University campus at *Gainesville*. The Extension Division concerns itself with all the agricultural work carried on by the University off the Campus. A county agent, for furthering agricultural work is located in each county. In addition to the county agent each county has a Home Demonstration Agent, whose duty it is to instruct the rural women and girls in better methods of homemaking and conservation of food. The Agricultural and Mechanical College for Negroes is located at *Tallahassee*. This institution is a separate organization from the Agricultural College, but is working under the direction of the same Board of Control.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 968,470; *752,619* |
| City | 355,825 (36.7%); *219,080 (29.1%)* |
| Country | 612,645 (63.3%); *533,539 (70.9%)* |
| Number of farmers | 54,005; *50,016* |
| White | 41,051 (76%); *35,295 (70.6%)* |
| Non-white | 12,954 (24%); *14,721 (29.4%)* |
| Land area, acres | 35,111,040 |
| Acres in farms | 6,046,691; *5,253,538* |
| Acres farm land improved | 2,297,271; *1,805,408* |
| Average acres per farm | 111.9 (42.5 improved); *105 (36.1* improved) |
| Farm land artificially drained | 147,940 acres (6.4% impr. land) |
| Farm land needing drainage | 687,021 (11.4% all farm land) |
| Farms by size: | |
| Up to 19 acres | 10,558; *9,084* |
| 20 " 49 " | 19,382; *17,169* |
| 50 " 99 " | 10,846; *9,999* |
| 100 " 174 " | 7,637; *8,178* |
| 175 " 499 " | 4,477; *4,545* |
| Over 500 " | 1,105; *1,041* |
| Value all farm property | $330,301 717; *$143,183 183* |
| Per cent increase in ten years | 130, *165.5* |
| Value farm land | $228,424,740; *$93,738,065* |
| " " buildings | $53,024,664; *$24,407,924* |
| " " implements | $13,551 773; *$4 446 007* |
| " " livestock | $35,300,450; *$20,591,187* |
| Av. value all property per farm | $6,116; *$2,863* |
| " " land and buildings per acre | $46.55; *$22.49* |
| Number farms run by owners | 38,487 (71.2%); *35,399 (70.7%)* |
| Number farms run by tenants | 13,689 (25.3%); *13,342 (26.7%)* |
| Per cent owned farms unmortgaged | 65; *83.7* |
| Per cent farms reporting automobiles | 16.2; telephones 8.4 |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | |
|---|---|
| Value, all farm crops | $80,256,806; *$33,217,656* |
| " all cereals | $14,528,809; *$6,175,973* |

| | | |
|---|---|---|
| Corn, acres | 790,487 | *605,771* |
| (bu.) | 8,831,112; | *7,023,767* |
| 10-yr. av. yield per acre | | 14.8 bu. |
| Rye, acres | 1,168; | *859* |
| (bu.) | 6,308; | *5,279* |
| Oats, acres | 17,207; | *43,206* |
| (bu.) | 222,226; | *606,380* |
| 10-yr. av. yield per acre | | 17.0 bu. |
| Tobacco, acres | 4,291; | *3,987* |
| lbs. | 4,473,696; | 3,505,801 |
| 10-yr. av. yield per acre | | 1,001 lbs. |
| Hay and forage, acres | 139,516; | *54,729* |
| tons | 99,432; | *55,300* |
| value | $2,510,772; | *$848,827* |
| Potatoes, white, acres | 17,525; | *8,509* |
| (bu.) | 1,767,196; | *856,967* |
| 10-yr. av. yield per acre | | 86 bu. |
| sweet, acres | 26,436; | *21,995* |
| (bu.) | 2,460,872; | *2,083,665* |
| 10-yr. av. yield per acre | | 106 bu. |
| Peanuts, acres | 77,416; | *126,150* |
| (bu.) | 1,365,063; | *2,315,089* |
| Sugar cane, acres | 20,143; | *12,928* |
| tons | 179,573; | *143,517* |
| Cotton, acres | 110,562; | *263,454* |
| bales | 19,538; | *65,056* |
| 10-yr. av. yield per acre | | 114 lbs. |
| Rice, acres | 2,391; | *623* |
| (bu.) | 39,157; | *12,341* |
| 10-yr. av. yield per acre | | 24.8 bu. |
| Strawberries, acres | 834; | *1,343* |
| quarts | 1,267,673; | *2,383,397* |
| Vegetables, acres, 60,250; value | $24,937,211; | *$8,385,242* |
| Apples, (bu.) | 139; | *3,405* |
| Peaches, (bu.) | 148,006; | *114,998* |
| Pears, (bu.) | 43,232; | *98,223* |
| Grapes, lbs. | 1,220,623; | *1,068,344* |
| Plums and prunes, bu. | 20,316; | *17,169* |
| Oranges, production, boxes | | 7,000,000 |
| value | | $17,500,000 |
| Forest products, value | $4,035,934; | *$2,375,882* |
| Nurseries, acres 1,863 in 127 establishments, receipts | | $935,843 |
| Greenhouses, sq. ft. under glass 326,474; receipts | | $353,578 |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| No. farms reporting livestock | 47,490 (pure breds 3,886) | |
| Value all livestock on farms | $35,300,540; | *$20,591,187* |
| Horses, number | 35,570; | *45,640* |
| value | $4,552,315; | *4,854,000* |
| Mules, number | 42,046; | *23,333* |
| value | $7,773,851; | *$3,545,821* |
| Cattle, all, number | 638,981; | *845,188* |
| value | $14,755,935; | *$9,262,262* |
| Beef, number | 518,350; | |
| Dairy, number | 120,631; | *116,041* |
| Sheep, number | 64,659; | *113,701* |
| value | $318,242; | *$256,166* |
| Goats, number | 45,890; | *47,871* |
| value | $146,331; | *$40,521* |
| Swine, number | 755,481; | *810,069* |
| value | $5,744,892; | *$1,848,731* |
| Poultry, number | 1,622,437; | *1,326,271* |
| value | $1,769,265; | *$673,814* |
| Bees, no. of hives | 41,237; | *38,895* |
| Livestock products, all, value, | $7,621,885; | *$3,498,796* |
| Value all dairy products | $2,361,196; | *$974,486* |
| " eggs and chickens | $4,893.258; | *2,386,076* |
| " wool and mohair | $99 737; | *$77,328* |
| " honey and wax | $267,694; | *$60,906* |
| Milk produced, gallons | | 12,155,533 |
| Butter made, lbs. | 1,162.383; | *1,705,274* |
| Eggs produced, dozens | 6,530,563; | *6,349,051* |

# GEORGIA

**GEORGIA** ("Empire of the South"), one of the Cotton Belt states and the largest east of the Mississippi River, is situated between 30 and 35 degrees north latitude, and 81 and 86 degrees west longitude. The Chattahoochee River forms about half the western boundary, and the Atlantic Ocean and Savannah River all of the eastern boundary. Area, 59,265 square miles, of which 540 are water. About 40,000 square miles are in forests.

**Land surface.** There are 3 general divisions: in the northwest are the Appalachian Mountains, with elevations of 3,000 to 5,000 feet, the highest point being Sitting Bull Mountain (5,046 feet). The Piedmont Plateau occupies the north central region. It merges, about the center of the state, into the Coastal Plain at an elevation of about 575 feet, and the latter slopes gently to the south and east to sea level at the coast. The northwest part of the state is drained by the Coosa and Tallapoosa Rivers, which reach the Gulf through the Alabama and Mobile Rivers. The southwest is drained by the Chattahoochee and Flint Rivers, uniting tc form the Apalachicola. The Altamaha drains the larger part of the southern and central part, flowing into the Atlantic, and navigable for a considerable distance. The

Savannah River, on the eastern boundary, is navigable as far as Augusta.

**Soils.** These are greatly diversified. Those of the Coastal Plain are largely sandy loams and clays, the river valleys being chiefly alluvial. The northern part has mainly a thin red soil, with a stiff red clay subsoil; and some limestone land.

**Climate.** The climate is said to cover 10 degrees of latitude in range, that of the northern mountainous region being not unlike that of the North Atlantic states. It is mainly temperate and healthful except along the southern coast region. Average rainfall for the state is 49.5 inches; it varies from 72 inches in the northeast to 39 inches in the east central part. Snow is usually scanty, occurring generally in January and February, but it has fallen all over the state and to a depth of 2 inches in the southern part. Records of more than 2 feet in a month have been made in the north. In the northern and western section, the highest recorded temperatures are 108 degrees at Quitman and 106 degrees at Thomasville, Albany and Lumpkin. Lowest on record are 12 degrees below zero at Tallapoosa, 11 below at Dahlonega, and 10 below at Greenbush and Ramsey, but such low temperatures are extreme and rare. The average annual temperature at Diamond (2,020 feet elevation) is 57 degrees. Earliest killing frost in autumn October 1 at Tallapoosa; average date at same place, October 30. Latest date of killing frost in spring, May 10 at Ramsey and Dahlonega; average date for these same places April 10. In southern and eastern section, highest recorded temperature is 107 degrees at Waycross and Point Peter in August; lowest 11 degrees below zero at Dahlonega in February. Average annual temperature at this place was 58.4.

**Opportunities.** Because of the differences in elevation, a great variety of agriculture and horticulture is possible. A narrow tidewater belt produces rice and subtropical fruits. The Coastal Plain region offers opportunities for both subtropical and temperate climate products, while the northern part is adapted to livestock and all northern products. In some parts and seasons, irrigation would be an advantage. Information about available farming lands may be obtained from the Commissioner of Agriculture, Atlanta.

**Products and industries.** Leading farm activities are the production of vegetables for the northern markets along the coast; cotton, pears and melons, a little inland; further back, peaches and grapes and upland cotton, and in the north, grains, apples, cherries and livestock. Georgia leads all states in the production of peaches. Trucking and fruit growing are increasing in importance. Anything that can be grown anywhere in the United States except tropical fruits can be grown somewhere in the state. Lumbering is an important industry. Fisheries are considerable, about half their value being in oysters. Minerals are not of great importance. Gold and silver have been found in small quantities, also coal, iron, granite, marble, asbestos, graphite. Georgia is a leading industrial state with excellent water power and favorable transportation facilities. Its manufactured products include cotton goods, timber, products, oil, fertilizers, turpentine and resin, hosiery and knit goods, marble and stone work, carriages and wagons, confectionery, leather goods, furniture and refrigerators.

**Transportation and markets.** All important railway systems of the South traverse Georgia. With their branches, they cover the state pretty thoroughly. Water communication is also excellent, by means of the larger rivers and the Atlantic from several ports.

**History.** First traversed by De Soto, 1540. Part of tract granted to the lord's proprietors of Carolina 1663–1665. Received provincial charter in 1719, and chartered as independent colony 1732. Put under provincial government in 1752. Provincial congress convened 1775. Remained under British control till 1782. In 1888 Georgia ratified the Federal constitution; a new state constitution went into effect in 1789, and another 1798, the latter prohibiting the importation of slaves. Seceded in 1861, ordinance repealed in 1865. After much conflict with Federal government, was readmitted in 1870. Capital, Atlanta; population, 1910, 154,839. Other leading cities, Savannah, 65,064; Augusta, 41,040; Macon, 40,665; Columbus, 20,554.

**Agricultural organization.** State College of Agriculture, *Athens;* Experiment Station, *Experiment;* Industrial College for colored youths, University of Georgia, *Savannah.* Commissioner of Agriculture, *Atlanta;* Agricultural Society, *Waycross;* Farmers' Union, *Douglas;* Horticultural Society, Dairy and Livestock Association, Breeders' Association, Forest Association, *Athens;* State Fair Association, *Macon;* Game Protective Association, *Atlanta.*

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Population | 2,895,832 | *2,609,121* |
| City | 727,859 (25.1%) | *538,650 (20.6%)* |
| Country | 2,167,973 (74.9%) | *2,070,471 (79.4%)* |
| Number of farmers | 310,732 | *291,027* |
| White | 180,545 (58.1%) | *168,468 (57.9%)* |
| Non-white | 122,559 (41.9%) | *130,176 (42.1%)* |
| Land area, acres | 37,584,000 | |
| Acres in farms | 25,441,061 | *26,953,413* |
| Acres farm land improved | 13,055,209 | *12,298,017* |
| Average acres per farm | 81.8 (42 impr.) | *92.6* (*42.3* impr.) |
| Acres artificially drained | 274,688 (2.1% imp. farm land) | |
| Acres needing drainage | 1,819,611 (7.2% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 26,969 | *29,629* |
| 20 " 49 " | 134,471 | *117,432* |
| 50 " 99 " | 81,112 | *68,510* |
| 100 " 174 " | 41,143 | *42,275* |
| 175 " 499 " | 22,753 | *27,710* |
| Over 500 " | 4,244 | *5,471* |
| Value all farm property | $1,356,685,196 | *$580,546,381* |
| Per cent increase in ten years | 133 | *154.2* |
| Value farm land | $897,444,961 | *$370,353,415* |

Value farm buildings....... $240,853,666; *$108,850,917*
" " implements.... $63,343,220; *$20,948,056*
" " livestock.......$155,043,349; *$80,393,993*
Av. value all property per farm..........$4,366; *$1,995*
" " land and buildings per acre.....$44.74; *$17.78*
Farms run by owners ..102,123 (32.8%); *98,628 (33.8%)*
Farms run by tenants, 206,954 (66.6%); *190,980 (65.6%)*
Per cent owned farms unmortgaged...........62.7; *79.1*
Per cent farms reporting automobiles 15.2; telephones 9.6

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops......... | $540,613,626; | *$216,971,974* |
| " " cereals............ | $96,516,194; | *$42,405,019* |
| Corn, acres.................. | 4,269,455; | *3,383,061* |
| production (bu.).... | 51,492,033; | *39,374,569* |
| 10-yr. av. yield per acre................ | | 15 bu. |
| Wheat, acres............. | 140,861; | *93,065* |
| production (bu.).... | 1,085,972; | *752,858* |
| 10-yr. av. yield per acre.............. | | 10.7 bu. |
| Oats, acres,............. | 187,525; | *411,664* |
| production (bu.).... | 2,758,851; | *6,199,243* |
| 10-yr. av. yield per acre............... | | 20 bu. |
| Rye. acres.............. | 18,041; | *12,352* |
| production (bu.).... | 100,209; | *59,937* |
| 10-yr. av. yield per acre............... | | 9.2 bu. |
| Cotton, acres............ | 4,720,498; | *4,883,304* |
| production (bales).. | 1,681,907; | *1,992,408* |
| 10-yr. av. yield per acre.............. | | 185 lbs. |
| Hay and forage, acres...................... | | 1,248,814 |
| production (tons).................... | | 608,597 |
| value............. | $17,284,086; | *$4,107,080* |
| Tobacco, acres............. | 25,067; | *2,025* |
| production (lbs.).... | 10,584,968; | *1,488,894* |
| Potatoes, white, acres....... | 11,195; | *11,877* |
| production (bu.).... | 693,857; | *886,430* |
| 10-yr. av. yield per acre................ | | 71 bu. |
| sweet, acres............. | 110,033; | *84,038* |
| production (bu.).... | 10,132,016; | *7,426,131* |
| 10-yr. av. yield per acre............... | | 98 bu. |
| Peanuts, acres............. | 201,786; | *160,317* |
| production (bu.).... | 3,826,505; | *2,569,787* |
| Sugar cane, acres........... | 41,558; | *37,046* |
| production (tons)... | 365,603; | *317,460* |
| Sorghum, acres............. | 37,311; | *14,170* |
| Sorghum, production (tons).. | 142,261; | *60,202* |
| Rice, acres.................... | 4,103; | *6,445* |
| production (bu.).... | 59,711; | *148,698* |
| Small fruits, acres.......... | 842; | *988* |
| production (quarts)... | 625,783; | *1,262,155* |
| Strawberries, acres.......... | 665; | *890* |
| production (quarts). | 503,693; | *1,157,472* |
| Vegetables, acres 36,763; value | $31,815,857; | *$10,614,601* |
| Apples, production (bu.)..... | 416,902; | *895,613* |
| Pears, production (bu.)...... | 178,181; | *149,667* |
| Peaches, production (bu.)..... | 4,788,718; | *2,555,499* |
| Plums and prunes, (bu.)..... | 64,053; | *60,845* |
| Grapes, production, (lbs.).... | 2,865,319; | *2,767,366* |
| Forest products, value....... | $21,657,200; | *$8,938,390* |

Nurseries: no. 104; acres 1,224; receipts .......$257,491
Greenhouses: sq. ft. under glass 905,070; receipts $500,420

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock............. | 297,678; | pure breds, 12,321 |
| Value all livestock on farms... | $155,043,349; | *$80,393,993* |
| Horses, number........... | 100,503; | *120,067* |
| value.............. | $13,434,117; | *$14,193,839* |
| Mules, number........... | 406,351; | *295,348* |
| value.............. | $77,986,306; | *$43,974,611* |
| All cattle, number........ | 1,756,738; | *1,080,316* |
| value.............. | $35,235,147; | *$14,060,958* |
| Beef cattle, number.... | 481,875; | |
| Dairy cattle, number. . | 674,863; | *405,710* |
| Sheep, number............ | 72,173; | *187,644* |
| value.............. | $323,615; | *$308,212* |
| Goats, number........... | 110,489; | *89,616* |
| value.............. | $211,319; | *$701,159* |
| Swine, number............ | 2,071,051; | *1,783,681* |
| Poultry, number.......... | 7,621,158; | *5,328,584* |
| value.............. | $6,879,535; | *$2,088,653* |
| Bees, number of hives...... | 136,698; | *130,549* |
| Livestock products, value..... | $36,401,316; | *$14,933,151* |
| Value all dairy products.... | $16,757,195; | *$6,621,585* |
| " eggs and chickens.... | $19,218,622; | *$8,091,630* |
| " honey and wax....... | $331,860; | *$101,888* |
| Milk produced (gallons).... | 101,615,773; | *74,908,776* |
| Butter made (lbs.)......... | 30,257,153; | *27,246,247* |
| Eggs produced (dozens)..... | 23,181,939; | *20,606,219* |


**IDAHO** ("Gem of the Mountains"), one of the Western Mountain States, lies between 42 and 49 degrees north latitude, and 111 and 118 degrees west longitude. It is irregular in shape, ranging in width from 50 to nearly 300 miles, with an extreme length of 485 miles. Area, 84,313 square miles, 534 of which are water.

**Land surface.** Idaho lies west of the Rocky Mountain divide, and is cut up by several minor ranges so that its varied surface includes mountains, fertile valleys and arid deserts. The altitudes vary from 783 feet at Lewiston on the west central boundary, to 12,078 feet at the top of Hyndman Peak on the east. The extreme southeast portion lies in the Great Salt Lake Basin. The remainder is drained by the Pend Oreille, Kootenai, Spokane and Snake Rivers and their tributaries of the Pacific slope. These all find their way to the Columbia River. Southeast of the center is a region, equal to Vermont in

size, drained by streams having no visible outlet. In the north and central portions are extensive forests.

**Soils.** Generally speaking, the soils are sand and silt loams of volcanic origin, in some sections, as in the broad Snake River Valley, lying undisturbed as when first deposited; in other sections, as on the Palouse and Nezperce prairies, they have been windblown, forming a peculiar hummocky topography. One prominent glaciated area in the northwest extends into Washington; this has a gravelly silt loam from 1 to 3 or 4 feet in depth strewn with boulders. In the river valleys is more or less alluvial soil, and the soil of the mountain meadows may, in many cases, be characterized by the same term. The sagebrush soils, as a rule, have great depth, are easily cultivated and, when put under irrigation and improved by the growth of alfalfa to improve their organic content, are highly productive. The open prairie soils, in more or less restricted areas in the south, and in vast expanses in the north, are of remarkable fertility from the time they are first brought under cultivation. The timbered soils are lighter than the preceding, but become highly productive when improved.

**Climate.** The climate is generally mild but varies widely. As a whole, it is influenced by the winds from the Pacific. The average annual temperature is reported as varying 15 degrees in a single county. In some parts in the south, flowers bloom outdoors in January. Lowest recorded temperature is 41 degrees below zero at Lost River, in February. The highest is 113 degrees at Garnet and Payette in July and August. Average annual temperatures range from 36.2 at Lake to 55.3 at Garnet. Temperatures are influenced not only by altitude but by the position of protecting mountains, by prevailing winds, and by the location of protected areas, air drainage on slopes and other natural features. Rainfall also varies widely. In the Pan Handle section, it ranges from 12 to 36 inches, but over much of the south, rainfall is so light that irrigation is generally necessary. The average annual rainfall for the state is only 13.2 inches, but the heavy snowfall upon the mountains furnishes abundant water for irrigation.

**Opportunities.** Idaho teems with agricultural opportunities. Lands of any required acreage in the raw condition, partially improved or highly improved, can be obtained at very reasonable prices. Livestock interests have an enormous asset in the national forests, where grazing lands are available at a nominal rental. Vast areas of public land are available for homestead or other entry, much capable of being developed into first-class farm lands, both irrigated and dry-farmed. The entryman may now file on 320 acres of land capable of being dry-farmed. Where conditions are otherwise favorable, dry-farmed land can be cultivated profitably with an annual rainfall as low as 12 inches. Approximately one half the land now under cultivation is being farmed by irrigation. There are two National reclamation projects within the state besides numerous other projects. Complete information relative to public land open to entry may be obtained from the land offices at Blackfoot, Boise, Hailey, Coeur d'Alene and Lewiston.

**Products and industries.** Leading farm activities are the raising of livestock (largely sheep), grain and all the orchard and horticultural products of the temperate zone. Wheat, oats, and barley are the leading grains. Apples, plums, peaches, pears, cherries and apricots grow to perfection, as do grapes and all small fruits. Fisheries are unimportant. Lumbering is an important industry. National Forest Reserves cover about 18,000,000 acres. Idaho has immense deposits of gold, silver, lead and copper, including the richest silver and lead mines known. Manufactures are increasing, lumbering, milling, cars and shop construction and printing and publishing being important.

**Transportation and markets.** The central part is not well supplied with railroads. River and lake communication is important locally. Leading market towns are Bonners Ferry, Sandpoint, Coeur d'Alene, St. Maries, Moscow, Lewiston, Payette, Weisen, Caldwell, Nampa, Boise, Twin Falls, American Falls, Shoshone, Idaho Falls, Blackfoot, St. Anthony, Ashton, Montpelier.

**History.** This begins with the explorations of Lewis and Clark in 1804–6. Idaho Territory first included Montana, which was separated in 1864, and Wyoming, separated in 1869. Gold discovered at Coeur d'Alene 1882. Admitted as a state in 1890. Capital, Boise; population, 1910, 28,000. Leading cities, Boise, Idaho Falls, Pocatello, Twin Falls, Moscow, Lewiston, Sandpoint.

**Agricultural organization.** College of Agriculture and Experiment Station, *Moscow;* Agricultural Extension and Coöperative Demonstration Work, Bureau of Farm Markets, *Boise.* Besides there are the State Horticultural Association, Pure Seed Association, Northwest Livestock Association. The State Fair is held at *Boise;* the Northwest Livestock Show at *Lewiston.*

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

Population....................................431,866; *324,594*
  City.......119,037 (27.6%); *69,898 (21.5%)*
  Country. .312,822 (72.4%); *255,696 (78.5%)*
Number of farmers.......................42,106; *30,807*
  White.....41,598 (98.8%); *30,402 (98.7%)*
  Non-white........508 (1.2%); *405 (1.3%)*
Land area, acres...............................50,346,560
Acres in farms......................8,375,873; *5,283,604*
Acres farm land improved..........4,511,680; *2,778,740*
Average acres per
  farm........198.9 (107.1 a. impr.); *171.5 (90.2 a impr.)*
Farm land artificially
  drained.......... 64,648 (1.4% impr. farm land)

| | | |
|---|---|---|
| Farm land needing drainage | 199,874 (2.4% of all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 2,917; | *2,005* |
| 20 " 49 " | 6,819; | *4,048* |
| 50 " 99 " | 8,502; | *5,820* |
| 100 " 174 " | 10,565; | *11,891* |
| 175 " 499 " | 10,488; | *5,866* |
| Over 500 " | 2,815; | *1,177* |
| Value all farm property | $716,137,910; | *$305,317,185* |
| Per cent increase in ten years | 131; | *353.9* |
| Value farm land | $511,865,869; | *$219,953,316* |
| " " buildings | $69,646,095; | *$25,112,509* |
| " " implements | $38,417,253; | *$10,476,051* |
| " " livestock | $96,208,693; | *$49,775,309* |
| Av. value all property per farm | $17,008; | *$9,911* |
| " " land and buildings per acre | $69.43; | *$46.38* |
| Number farms run by owners | 34,647 (82.2%); | *27,169 (88.1%)* |
| Number farms run by tenants | 6,701 (15.9%); | *3,188 (10.3%)* |
| Per cent owned farms unmortgaged | 34.3; | *66* |
| Per cent farms reporting automobiles 39.5; telephones 32.9 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $126,495,111; | *$32,880,915* |
| " " cereals | $43,155,745; | *$6,026,676* |
| Corn, acres | 23,277; | *9,194* |
| production (bu) | 640,569; | *318,181* |
| 10-yr. av. yield per acre | 34.2 bu. | |
| Wheat, acres | 1,141,295; | *399,234* |
| production (bu) | 17,877,113; | *10,238,609* |
| 10-yr. av. yield per acre | 24.7 bu. | |
| Oats, acres | 141,507; | *302,783* |
| production (bu) | 3,069,132; | *11,328,106* |
| 10-yr. av. yield per acre | 42.6 bu. | |
| Rye, acres | 11,937; | *3,295* |
| production (bu) | 81,854; | *40,241* |
| 10-yr. av. yield per acre | 18.2 bu. | |
| Barley, acres | 67,871; | *132,412* |
| production (bu) | 1,348,876; | *4,598,292* |
| 10-yr. av. yield per acre | 37 bu. | |
| Hay and forage, acres | 1,189,220 | |
| production (tons) | 2,330,543 | |
| value | $50,802,765; | *$12,101,239* |
| Potatoes, white, acres | 43,196; | *28,341* |
| production (bu) | 6,300,835; | *4,710,262* |
| 10-yr. av. yield per acre | 164 bu. | |
| Sugar beets, acres | 37,334; | *15,598* |
| production (tons) | 260,309; | *179,638* |
| Small fruits, acres | 1,240; | *1,673* |
| production (quarts) | 1,106,208; | *2,071,141* |
| Strawberries, acres | 469; | *698* |
| production (quarts) | 494,818; | *953,723* |
| Vegetables, acres 2,097: value | $15,677,765; | *$2,591,199* |
| Apples, production (bu) | 3,645,640; | *659,959* |
| Pears, production (bu) | 47,847; | *42,649* |
| Peaches, production (bu) | 279,101; | *18,734* |
| Plums and prunes (bu) | 485,325; | *179,027* |
| Grapes, production (lbs) | 519,544; | *604,227* |
| Forest products, value | $2,329,244; | *$1,280,512* |
| Nurseries: acres 95 in 26 establishments; receipts $45,335 | | |
| Greenhouses: sq. ft. under glass 237,431; receipts $114,511 | | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock 39,553; purebreds 6,431 | | |
| Value all livestock on farms | $96,208,693; | *$49,775,309* |
| Horses, number | 293,123; | *197,772* |
| value | $24,368,376; | *$19,832,423* |
| Mules, number | 7,735; | *4,036* |
| value | $810,787; | *$481,301* |
| All cattle, number | 714,903; | *453,807* |
| value | $36,382,229; | *$11,330,639* |
| Beef cattle, number | 512,512 | |
| Dairy cattle, number | 202,391; | *86,299* |
| Sheep, number | 2,356,270; | *3,010,478* |
| value | $29,249,088; | *$15,897,192* |
| Goats, number | 1,515; | *5,719* |
| value | $14,808; | *$ 36,697* |
| Swine, number | 240,030; | *178,346* |
| value | $3,567,413; | *$1,398,727* |
| Poultry, number | 1,711,884; | *1,053,876* |
| value | $1,489,053; | *$598,190* |
| Bees, number of hives | 35,900; | *21,903* |
| Livestock products, value | $22,225,355; | *$7,749,434* |
| Value all dairy products | $8,065,646; | *$1,962,500* |
| " eggs and chickens | $5,062,276; | *$2,349,131* |
| " wool and mohair | $8,753,178; | *$3,349,421* |
| " honey and wax | $344,255; | *$88,382* |
| Milk produced (gallons) | 52,365,498; | *20,861,075* |
| Butter made (lbs) | 4,540,364; | *3,542,132* |
| Eggs produced, dozens | 8,604,809; | *6,433,840* |

### 4. Irrigation, 1920 and *1910*

| | | |
|---|---|---|
| Acres in irrigation projects | 3,780,048; | *3,549,573* |
| " of projects irrigable | 3,092,810; | *2,388,959* |
| " " " irrigated | 2,488,806; | *1,430,848* |
| " irrigated land open to settlement | 118,334 | |
| Capital invested in projects | $91,501,009; | *$40,977,688* |
| Investment, per acre | $29.59; | *$17.15* |
| Estimated final cost | $97,019,717; | *$58,451,106* |
| Av. cost per acre | $25.67; | *$16.47* |
| Av. cost maintenance and operation, per acre | $1.17; | *$.63* |
| Acreage crops on irrigated land (1919) | 1,203,270 | |
| Value crops on irrigated land. (1919) | $76,830,746 | |
| Av. value crops on irrigated land per acre | $63.85 | |

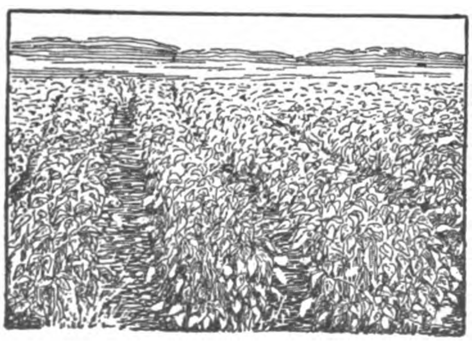


FIG 372.—A field of soy beans grown for seed

# ILLINOIS

**ILLINOIS** ("Prairie State"), one of the North Central Corn Belt States, situated between 36 and 44 degrees north latitude, and 87 and 92 degrees west longitude. The Mississippi River forms the entire western boundary, the Wabash and Ohio Rivers the southern, and Lake Michigan the northeastern. Area, 56,665 square miles, 663 of which are water. Its extreme length is 385 miles and its extreme width 218 miles.

**Land surface.** Illinois is 267 feet above sea level in the southern part at the junction of the Ohio and Mississippi Rivers, gradually rising with an undulating surface to slightly more than 1,000 feet at several points in the northwest. Most of the state has an elevation of 400 to 600 feet. One considerable elevation extends from the northwest corner southeast to the Illinois River; another crosses the state from east to west just south of parallel 38 degrees north latitude. The drainage is mostly to the Mississippi River. The Illinois, the largest river within the state, flows into the Mississippi and connects with the Chicago River and Lake Michigan by the Illinois and Michigan canal. It has several tributary rivers, as has the Ohio in the south. Large areas along the Mississippi and Ohio Rivers are subject to overflow.

**Soils.** The soils are largely of glacial origin, except in the lower river valleys, which are water-formed. In the west and west central part of the state, this glaciated upland is covered by a deep layer of brown or yellow silty loam known as the loess. The southeastern portion is chiefly occupied by a shallow covering of loess-like material, gray or ash-colored, compact and dense, differing in this respect from the brown or yellow, well-drained and friable loess of the deeper areas. In the east central and northern portion are brown to almost black loams and silty loams, except in the depressed areas. All are well suited to all the staple crops of the climate, though many of them require drainage.

**Climate.** The temperatures vary considerably between the more elevated northwest and the southern part. Highest and lowest recorded temperatures in the north are 112 degrees above and 32 degrees below zero; average annual temperature 48.7 degrees. The average frost-free season is 162 days; average annual rainfall 34 inches; and annual snowfall 31.5 inches. In the central section, highest and lowest recorded temperatures are 112 degrees and 30 degrees below zero; average annual temperature is 52 degrees; average frost-free season 170 days; average annual rainfall 35.66 inches; snowfall 23.5 inches. In the south, highest and lowest recorded temperatures are 113 degrees and 25 degrees below zero; average annual temperature, 55.8 degrees. In the extreme south, 16 degrees below zero has been recorded, but the frost-free season averages 185 days; average annual rainfall, 40.47 inches and snowfall 16.2 inches. Northern Illinois lies within the principal storm tracks that cross the country, hence is subject to sudden and decided changes in weather conditions and temperature, especially in winter.

**Opportunities.** Prices for desirable land are high, and little if any public land is left. Information may be obtained from the Experiment Station, Urbana, or the Board of Agriculture, Springfield.

**Products and industries.** Leading farm activities are the production of corn (in which Illinois has led all the states for many years), oats, wheat, and other grains, hay and forage, and livestock (especially beef cattle, horses and swine, and dairy cows, sheep and mules in considerable numbers). River and lake fisheries are considerable. Soft coal is the leading mineral, its area of production being the largest of any state, and covering more than one half the counties. Limestone and clay products are also important. In manufactures, Illinois leads all states west of the Alleghenies, and is exceeded by only two of

the 48 states. The leading industry of this type is slaughtering and meat packing, in which the manufacture of the by-products is extensive. Other important manufactured products include foundry and machine-shop products, agricultural implements and vehicles, automobiles; until about 1917 large amounts of distilled liquors; clothing; flour and by-products; glucose; electrical supplies; furniture and other timber products; boots and shoes. Chicago is the chief manufacturing city, most of the slaughtering and packing, as well as many other lines, centering there.

**Transportation and markets.** Illinois is admirably located for securing transportation facilities in every direction. The water communication over Lake Michigan and the Ohio and Mississippi rivers is unexcelled. Chicago, the only port of entry, ranks all other lake ports in domestic commerce, is fourth in foreign commerce and is the leading market city.

**History.** First explored by La Salle from the Chicago to the Illinois rivers in 1671. By 1750, the French had established a number of important trading settlements. Ceded to English by treaty of 1763. Formally ceded to the United States in 1783.

**Agricultural organization.** College of Agriculture and Experiment Station, Coöperative Demonstration Work, *Urbana*. Department of Agriculture, with Director and 9 bureaus, *Springfield*. There are a State Horticultural Society, Illinois Farmers' Institute, State Dairymen's Association, Live Stock Breeders' Association, Illinois Poultry Association, Beekeepers' Association, Illinois Agricultural Press Association, Highway Commission, Horse Breeders' Association, Cattle Breeders' Association, Swine Breeders' Association, Sheep Breeders' Association and others. The State Fair is held at *Springfield*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 6,485,280; | *5,638,591* |
| City | 4,403,153 (67.9%); | *3,476,929 (61.7%)* |
| Country | 2,082,127 (32.1%); | *2,161,662 (38.3%)* |
| Number of farmers | 237,181; | *251,872* |
| White | 236,164 (99.6%); | *250,447 (99.4%)* |
| Non-white | 893 (0.4%); | *1,425 (0.6%)* |
| Land area, acres | | 35,867,520 |
| Acres in farms | 31,974,775; | *32,522,937* |
| Acres farm land improved | 27,294,533; | *28,048,323* |
| Av. acres per farm | 134 (115 impr.); | 129.1 (*111.4* impr.) |
| Acres artificially drained | 11,247,637 (41.2% impr. farm land) | |
| Acres needing drainage | 1,228,739 (3.8% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 16,710; | *20,294* |
| 20 " 49 " | 26,980; | *33,322* |
| 50 " 99 " | 51,920; | *57,917* |
| 100 " 174 " | 81,459; | *80,539* |
| 175 " 499 " | 58,186; | *57,755* |
| Over 500 " | 1,917; | *2,045* |
| Value all farm property | $6,666,767,235; | *$3,905,321,075* |
| Per cent increase in ten years | 70.7; | *94.8* |
| Value farm land | $5,250,294,752; | *$3,090,411,148* |
| " " buildings | $747,698,814; | *$432,381,422* |
| " " implements | $222,619,605; | *$73,724,074* |
| " " livestock | $446,154,064; | *$308,804,431* |
| Av. value all property per farm | $28,108; | *$15,505* |
| " " land and buildings per acre | $187.59; | *$108.32* |
| Farms run by owners | 132,574 (55.9%); | *145,107 (57.6%)* |
| Farms run by tenants | 101,196 (42.7%); | *104,379 (41.4%)* |
| Per cent owned farms unmortgaged | 52.0; | *59.8* |
| Per cent farms reporting automobiles 52.9; telephones 73.2 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $864,737,833; | *$364,190,261* |
| " " cereals | $684,753,430; | *$297,523,098* |
| Corn, acres | 7,908,385; | *10,045,839* |
| production (bu.) | | 285,346,031 |
| 10-yr. av. yield per acre | | 33.7 bu. |
| Wheat, acres | 4,103,035; | *2,185,091* |
| production (bu.) | 70,890,917; | *37,830,732* |
| 10-yr. av. yield per acre | | 16.3 bu. |
| Oats, acres | 4,291,066; | *4,176,485* |
| production (bu.) | 129,104,668; | *150,386,074* |
| 10-yr. av. yield per acre | | 37.4 bu. |
| Rye, acres | 319,636; | *58,973* |
| production (bu.) | 3,872,621; | *787,519* |
| 10-yr. av. yield per acre | | 16.8 bu. |
| Barley, acres | 176,792; | *63,325* |
| production (bu.) | 4,226,911; | *1,613,559* |
| 10-yr. av. yield per acre | | 31.2 bu. |
| Hay and forage, acres | | 4,013,476 |
| production (tons) | | 7,063,254 |
| value | $120,790,711; | *$40,566,162* |
| Potatoes, white, acres | 86,384; | *138,052* |
| production (bu.) | 4,699,134 ; | *12,166,091* |
| 10-yr. av. yield per acre | | 70 bu. |
| sweet, acres | 8,003; | *10,568* |
| production (bu.) | 668,845; | *1,050,932* |
| 10-yr. av. yield per acre | | 91 bu. |
| Buckwheat, acres | 4,138; | *4,696* |
| production (bu.) | 52,771; | *68,125* |
| Sorghum, acres | 10,654; | *14,846* |
| production (tons) | 41,767; | *89,421* |
| Maple sugar, trees tapped | 38,341; | *48,098* |
| production (lbs.) | 1,436; | *5,366* |
| Small fruits, acres | 11,215; | *11,723* |
| production (quarts) | 10,591,818; | *13,602,676* |
| Strawberries, acres | 4,985; | *5,410* |
| production (quarts) | 6,901,199; | *8,031,824* |
| Vegetables, acres 60,705; value | $31,351,407; | *$16,300,654* |
| Apples, production (bu.) | 4,673,117; | *3,093,321* |
| Pears, production (bu.) | 374,925; | *249,365* |
| Peaches, production (bu.) | 449,601; | *1,222,570* |
| Plums and prunes, (bu.) | 83,017; | *78,566* |
| Grapes, production (lbs.) | 10,339,018; | *16,582,785* |
| Forest products, value | $6,259,154; | *$3,325,259* |
| Nurseries: acres 1,869 in 155 establishments; receipts | | $780,092 |
| Greenhouses, sq. ft. under glass 19,626,091; receipts | | $9,978,606 |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 231,744; | pure breds 52,545 |
| Value all livestock on farms | $446,154,064; | *$308,804,431* |
| Horses, number | 1,296,852; | *1,452,887* |
| value | $118,708; | *$163,363,400* |
| Mules, number | 168,274; | *147,833* |
| value | $20,628,517; | *$18,140,335* |
| All cattle, number, | 2,788,238; | *2,440,577* |
| value | $182,258,690; | *$73,454,745* |
| Beef cattle, number | | 1,283,178 |
| Dairy cattle, number | 1,505,060; | *1,050,000* |
| Sheep, number | 637,685; | *1,059,846* |
| value | $7,946,064; | *$4,834,736* |
| Goats, number | 9,977; | *12,435* |
| value | | $48,290 |
| Swine, number | 4,639,182; | *4,686,362* |
| value | $90,203,036; | *$36,210,179* |
| Poultry, number | 25,864,558; | *21,409,835* |
| value | $25,234,061; | *$11,696,650* |
| Bees, number of hives | 162,630; | *155,846* |
| Livestock products, value | $142,351,262; | *$67,390,680* |
| Value all dairy products | $71,998,333; | *$31,542,209* |
| " eggs and chickens | $67,690,085; | *$34,344,482* |
| " wool and mohair | $2,219,526; | *$1,303,226* |
| " honey and wax | $443,318; | *$200,763* |
| Milk produced (gallons) | 370,486,981; | *46,609,992* |
| Butter made (lbs.) | 25,063,897; | *46,609,992* |
| Eggs produced (dozens) | 105,757,907; | *99,118,224* |

# INDIANA

**INDIANA** ("Hoosier State"), one of the north central Corn-Belt States, lying between 37 and 44 degrees north latitude, and 84 and 89 degrees west longitude. Area, 36,354 square miles, of which 469 are water.

**Land surface.** Indiana lies partly in the Mississippi Valley and partly in the Great Lakes Basin. In general, the gently rolling surface slopes toward the southwest, where the lowest elevation (370 feet) is found. The highest land is in the northeast and along the east central border, and the highest point (1,208 feet) at Carlos City. The Wabash River and its tributaries rising in Ohio and reaching the Ohio River on the southwestern boundary, drain a large part of the state. The southern part drains directly into the Ohio River, the northwestern into Lake Michigan, and the northeastern into Lake Erie. The region along Lake Michigan is low and some of it swampy. Along the Ohio and lower Wabash Rivers, the land is subject to overflow. The country toward the south abounds in isolated hills, narrow valleys and precipitous cliffs. A large part of the central part is typical prairie.

**Soils.** Except in the south, these are largely alluvial of glacial origin. The loams are brown, gray and black. In the northwest, is an extensive level area formerly marshy but now drained, on which the soils are largely black, sandy loams and mucks. In the "hill region" in the south, there is more clay and the soil is not so fertile, but suited for general farm crops, orchards and livestock. In the lower river valleys are alluvial soils.

**Climate.** In general, this is mild and even. Cold winds from the lake region cause sudden changes in the north at times. Average annual temperature in the north is about 50 to 52 degrees; in the south, 54. Highest recorded temperature is 111 degrees at several different stations. The lowest is 33 degrees below zero, an exceptional record. The average frost-free season is about 160 days. Northern Indiana is subject to severe winter storms which sweep across the state. Average annual rainfall in the northern section is 36 inches; in the south somewhat more—from 37 to 55 inches, one station recording 55 inches. Average annual snowfall varies from 12 inches in the southwest to about 40 inches in the north.

**Opportunities.** Fertile soils throughout most of the state, adaptable to all farm and orchard products, a congenial climate, abundant rainfall, good transportation facilities, make the state an excellent one for the farmer. No abandoned farms are reported.

**Products and industries.** "Corn is King," exceeding in value all other cereals. Wheat, oats, hay and forage, potatoes, and tobacco are the leading farm crops, though all staple crops are produced to some extent. Fruit growing is extensive, apples and peaches being the leading tree fruits, grapes and small fruits being largely grown. Trucking is an extensive industry on the drained swamps in the northwest. Melon growing is important in several sections, while Indiana claims to lead in the production of tomatoes, largely for canning. Livestock is very important, hogs leading in number followed by cattle, sheep and horses. In value, horses rank first, cattle, hogs, mules and sheep following in order. Dairying is extensive, both for milk for city markets and for the manufacture of butter, cheese, ice cream and evaporated and condensed milk. Poultry exceed sheep in value, the state ranking high in this industry. Limited fisheries are carried on in Lake Michigan and the Ohio River and its tributaries, more than half the value being obtained from mussels. Lumbering has declined, oak being the principal timber at present. Coal and petroleum are the leading minerals, and the state is famous for its Bedford stone, one of the finest building stones for all purposes. Manufactures are

extensive and valuable. Leading ones are meat products, flour and grist-mill products steel, automobiles, rubber goods, carriages and wagons, furniture, agricultural implements, railroad cars, canned goods, clothing, electrical supplies, cement, dairy products.

**Transportation and markets.** Transportation facilities are unexcelled, especially by railways, practically all transcontinental lines crossing the state. Indianapolis is a great railroad center for lines extending in all directions. Indiana ranks second in mileage of electric railways, and claims to be first in service to farms and factories. Many of these are interstate lines. The state also claims a greater mileage of improved highways than any other state. Water communication to the north and east is furnished by Lake Michigan on the north, and to the Mississippi Valley and the Gulf of Mexico by the Ohio River and its tributaries. Evansville and Indianapolis are ports of entry and good markets. Other market towns in the State are New Albany, Fort Wayne, South Bend, Terre Haute, Hammond, Gary.

**History.** First explorer, La Salle, 1679–80; the French erected a fort at Vincennes 1702 and made first permanent settlement shortly after. The English occupied the territory in 1763. Ceded to the United States 1783. Admitted to the Union 1816. Capital, Indianapolis; population, 1910, 233,650.

**Agricultural organization.** Agricultural College and Experiment Station, parts of Purdue University, and Coöperative Demonstration work, *Lafayette;* Board of Agriculture, *Kentland;* Swine Breeders' Association, *Union City*; Sheep Breeders' and Feeders' Association, *Indianapolis*; Corn Growers' Association, Livestock Breeders' Association, Cattle Feeders' Association, Dairy Association, Horticultural Society, Draft Horse Breeders' Association, Federation Associations, Stallion Registration Board, all *Lafayette.* The State Fair is held at *Indianapolis.*

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

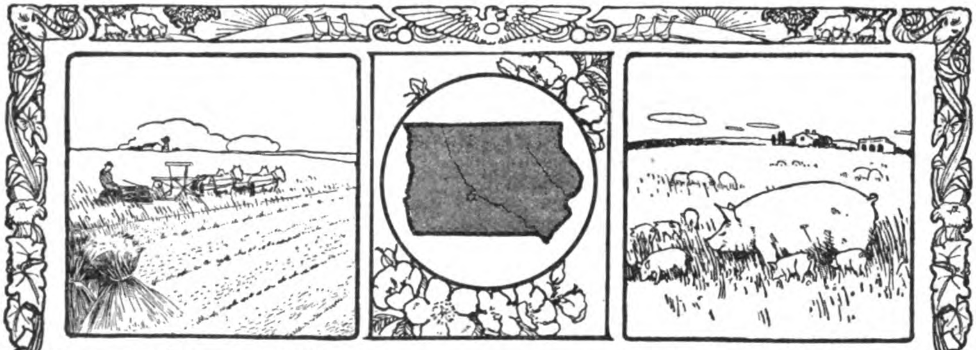
| | | |
|---|---|---|
| Population | 2,930,390; | *2,700,867* |
| City | 1,482,855 (50.6%); | *1,143,835 (42.4%)* |
| Country | 1,447,535 (49.4%); | *1,557,041 (57.6%)* |
| Number of farmers | 205,126; | *215,485* |
| White | 204,554 (99.4%); | *214,680 (99.3%)* |
| Non-white | 572 (0.6%); | *805 (0.7%)* |
| Land area, acres | 23,068,600 | |
| Acres in farms | 21,063,323; | *21,299,823* |
| Acres farm land improved | 16,680,212; | *16,931,252* |
| Average acres per farm | 102 (81 impr.); | *98.8* (*78.6* impr.) |
| Acres artificially drained | 8,308,844 (49.8% impr. farm land) | |
| Acres needing drainage | 1,717,068 (*8.2 %* all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 19,916; | *23,644* |
| 20 " 49 " | 34,949; | *40,161* |
| 50 " 99 " | 65,066; | *67,221* |
| 100 " 174 " | 57,895; | *57,261* |
| 175 " 499 " | 58,186; | *57,755* |
| Over 500 " | 1,917; | *2,045* |
| Value all farm property | $3,042,311,247; | *$1,809,135,238* |
| Per cent increase in ten years | 68; | *84.9* |
| Value farm land | $2,202,566,336; | *$1,328,196,545* |
| " " buildings | $451,077,637; | *$266,079,051* |
| " " implements | $127,403,086; | *$40,999,541* |
| " " livestock | $261,264,188; | *$173,860,101* |
| Av. value all property per farm | $14,831; | *$8,396* |
| " " land and buildings per acre | $125,98; | *$74.85* |
| Farms run by owners | 137,210 (66.6%); | *148,501 (72.4%)* |
| Farms run by tenants | 65,587 (32.0%); | *64,687 (30.0%)* |
| Per cent owned farms unmortgaged | 53.4; | *60.5* |
| Per cent farms reporting automobiles 46.4; telephones 66.4 | | |

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value all farm crops | $497,229,719; | *$196,869,691* |
| " " cereals | $378,981,813; | *$151,898,146* |
| Corn, acres | 4,457,400; | *4,901,054* |
| production (bu.) | 158,603,938; | *195,496,433* |
| 10-yr. av. yield per acre | | 36.4 bu. |
| Wheat, acres | 2,798,657; | *2,082,835* |
| production (bu.) | 45,207,862; | *33,935,972* |
| 10-yr. av. yield per acre | | 15.4 bu. |
| Oats, acres | 1,718,748; | *1,667,818* |
| production (bu.) | 52,529,723; | *50,607,913* |
| 10-yr. av. yield per acre | | 34.6 bu. |
| Rye, acres | 350,908; | *83,440* |
| production (bu.) | 4,432,091; | *1,121,589* |
| 10-yr. av. yield per acre | | 14.9 bu. |
| Barley, acres | 74,239; | *10,188* |
| production (bales) | 1,427,772; | *234,298* |
| 10-yr. av. yield per acre | | 28. bu. |
| Hay and forage, acres | 3,303,056; | *2,300,579* |
| production (tons) | 5,133,742; | *2,880,104* |
| Value | $79,874,640; | *$24,902,395* |
| Potatoes, white, acres | 62,192; | *99,504* |
| production (bu.) | 2,477,034; | *8,905,679* |
| 10-yr. av. yield per acre | | 76 bu. |
| sweet, acres | 3,409; | *1,561* |
| production (bu.) | 195,515; | *178,300* |
| 10-yr. av. yield per acre | | 105 bu. |
| Sorghum, acres | 12,307; | *11,829* |
| production (tons) | 52,210; | *77,600* |
| Maple sugar trees tapped | 558,368; | *742,586* |
| Sugar produced (lbs.) | 14,487; | *33,419* |
| Small fruits, acres | 7,565; | *5,919* |
| production (quarts) | 6,812,972; | *7,424,831* |
| Vegetables, acres 53,468; value | $21,254,878; | *$1,454,0362* |
| Apples, production (bu.) | 925,624; | *2759,134* |
| Pears, production (bu.) | 109,463; | *319,925* |
| Peaches, production (bu.) | 82,266; | *1174,389* |
| Plums and prunes, (bu.) | 33,536; | *77,065* |
| Grapes, production (lbs.) | 6,612,804; | *12,817,353* |
| Forest products, value | $10,955,856; | *$5,603,332* |
| Nurseries: acres 1,330 in 123 establishments, receipts | | $409,475 |
| Greenhouses: sq. ft. under glass 7,229,383; receipts | | $3,056,094 |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Number farms reporting livestock | 197,929; | pure breds 31,127 |
| Value all livestock on farms | $261,264,188; | *$173,860,101* |
| Horses, number | 713,233; | *813,644* |
| value | $66,703,216; | *$87,118,468* |
| Mules, number | 100,358; | *82,168* |
| value | $11,988,392; | *$9,678,014* |
| All cattle, number | 1,546,095; | *1,837,607* |
| value | $94,529,884; | *$39,110,492* |
| Beef cattle, number | | 599,694 |
| Dairy cattle, number | 946,401; | *633,591* |
| Sheep, number | 643,889; | *1,336,967* |
| value | $7,628,968; | *$5,908,496* |
| Goats, number | 7,872; | *7,290* |
| value | | $37,294 |
| Swine, number | 3,757,135; | *3,613,906* |
| value | $63,095,220; | *$23,739,586* |
| Poultry, number | 17,147,576; | *13,789,109* |
| value | $16,757,365; | *$7,762,015* |
| Bees, number of hives | 87,045; | *80,938* |
| Livestock products, value | $99,350,023; | *$44,319,539* |
| Value all dairy products | $44,072,646; | *$16,666,374* |
| " eggs and chickens | $52,765,970; | *$26,013,342* |
| " wool and mohair | $2,322,127; | *$1,534,108* |
| " honey and wax | $189,280; | *$105,715* |
| Milk produced (gallons) | 238,793,861; | *194,736,962* |
| Butter made (lbs.) | 18,344,239; | *43,181,817* |
| Eggs produced (dozens) | | 83,101,293 |



# IOWA

**IOWA** ("Hawkeye State"), one of the North Central States, situated between 40 and 44 degrees north latitude, and 89 and 97 degrees west longitude. The Mississippi River forms the eastern boundary, the Missouri and Big Sioux Rivers the western. Area, 56,025 square miles, of which 550 are water.

**Land surface.** The surface is largely a gently rolling prairie, nearly level and sloping gradually from the northwest (elevation of about 1,800 feet) to the southeast where, at Keokuk, the lowest elevation, 477 feet, is reached. The average elevation is somewhat more than 1,000 feet. About the only rough surface is that of the steep bluffs along the rivers. Two-thirds of the state drains into the Mississippi River, the remainder into the Missouri. The highland dividing the two river systems extends from a little west of the center of the southern boundary, irregularly north-northwest across the state. There are numerous small and beautiful lakes in the north central part of the state. There are no extensive forests, but some timber belts along the streams. The lowlands along the rivers are sometimes subject to overflow. Principal tributaries of the Mississippi River are the Des Moines, Iowa, Cedar, Wapsipinicon, and of the Missouri, Big Sioux and Little Sioux Rivers. It is said that 97 per cent of the land surface is tillable, though some of it needs draining.

**Soils.** The soil is largely of glacial origin but free from boulders, and remarkably fertile and easily worked. The prairie soil is a black loam of sand and clay. In the Mississippi and Missouri Valleys is found a layer of loess—a fine, yellowish sand and clay. The soil of the other river bottoms is alluvial.

**Climate.** The winters are moderately cold and the summers, while hot, are not usually extreme. The average annual temperature is about 47 degrees; the highest recorded temperature 112 degrees; the lowest, 36 degrees below zero. These extremes are unusual. The frost-free season is about 160 days, a little longer in the southwest. The average annual rainfall is about 33 inches, the precipitation being heaviest along the Mississippi River. The snowfall is comparatively light.

**Opportunities.** No public lands are available. The prices of farm lands range from $100 to $300 per acre, and there is very little land that can be bought for less than $100 per acre. Information may be obtained from the Agricultural Experiment Station, Ames.

**Products and industries.** Leading farm activities are the production of cereals, livestock and fruits of nearly all kinds. Iowa has led the states in the production of many farm crops. Corn is the leading cereal, followed by oats, wheat, barley, rye, buckwheat, flaxseed and others. It is among the leaders in livestock, and dairying is extensive all over the state. Great numbers of swine are raised, many horses, mules and sheep; poultry is a valuable product. It is said that no other state feeds so large a part of its grain products to its farm animals. Iowa abounded in native fruits and nuts, many of which have been bred and developed into valuable varieties. Most fruits succeed best in the southern part, the soil seeming to be more favorable. Apples are the leading fruit, followed by plums and prunes, cherries and grapes. Pears succeed in few localities. Peaches are grown in limited quantities in the southwest. Most small fruits succeed well everywhere, but require more care in the northern part. The only important mineral is coal, in the production of which Iowa ranks second among the states west of the Mississippi. Clay and clay products and limestone are valuable. Manufactures are not so important as in some other states, but are increasing and well distributed throughout the state. Most important of all are the slaughtering and meat-packing industries; next is factory-made butter, cheese and condensed milk, the larger part of the value of these being in butter; flouring; car con-

struction; carriages and wagons. There are no great manufacturing centers.

**Transportation and markets.** Iowa ranks high in railway mileage, 10,000 miles, and the state is well covered. Several of the great trunk lines cross it; connecting and local lines are numerous. Des Moines is the leading railroad center and an important market, as are Keokuk, Davenport, Dubuque, Sioux City, Cedar Rapids, Burlington, Council Bluffs. River communication is important on the Mississippi. There are, in round numbers, 100,000 miles of public highways, which are being uniformly graded, and many of them surfaced with gravel. The Lincoln Highway passes through the State from east to west, and the Jefferson Highway from north to south, intersecting about the middle of the state.

**History.** Named from the Iowa Indians, meaning beautiful land. From 1788 to 1810 the French had a trading and mining settlement at Dubuque. The region was ceded to the United States as part of Louisiana in 1803. Several settlements along the Mississippi made in 1833 and succeeding years. After being successively apportioned to the territories of Missouri, Michigan and Wisconsin, Iowa was organized as a separate territory in 1838, with the capital at Burlington. It embraced the greater part of the present state of Minnesota and all of the Dakotas. Admitted to the Union with its present boundaries in 1846. Des Moines became the capital 1857; population, 1910, 86,368.

**Agricultural organization.** Department of Agriculture, Des Moines. College of Agriculture and Mechanic Arts and Experiment Station, Coöperative Demonstration Work, Forestry and Conservation Association, *Ames.* Horticultural society, Society of Iowa Florists, Western Grain Dealers' Association, *Des Moines;* Iowa Corn and Small Grain Growers' Association, *Ames;* Corn Belt Meat Producers' Association, *Des Moines;* Beef Producers' Association, *Mt. Pleasant;* State Highway Association, *Ames;* Swine Breeders' Association, *Rolfe;* Dairy Association, Iowa Falls; Draft Horse Breeders' Association, *Des Moines;* Shorthorn Breeders' Association, *Marion;* Aberdeen-Angus Cattle Breeders' Association, *Newton;* Beekeepers' Association, *Center Point;* Poultry Association, *Cedar Rapids;* Fish and Game Protective Association, *Dubuque;* Sheep Breeders' Association, *Bloomfield;* Shropshire Breeders' Association, *Ames;* Meat Producers' Association, *Des Moines.* State Fair annually at *Des Moines.*

The 1917 Legislature appropriated $50,000 annually for soil survey work.

The Experiment Station Director reports that, although Iowa ranks fifteenth in population and twenty-third in area of land, she ranks first in total value of farm products, combined value of livestock, value of farm property per farm, increased value of farm property during decade ending 1910, percentage of farm land improved, percentage of total area in farms, number of automobiles per capita, value of horses, value of cattle, value of hogs, number of poultry, value of egg production, value of farm implements, tonnage of forage crops, production of corn, production of oats, and production of grass seed.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

Population ........................2,404,021; *2,224,771*
City........875,495 (36.4%); *680,054 (30.6%)*
Country..1,528,526 (63.6%); *1,544,717 (69.4%)*
Number of farmers....................213,439; *217,044*
White...213,330 (99.9%); *216,843 (99.9%)*
Non-white..........109 (.1%); *201 (.1%)*
Land area, acres...........................35,575,040
Acres in farms..................33,474,896; *33,930,688*
Acres farm land improved........28,606,951; *29,491,199*
Average acres per farm 156 (134 impr.); *156.3* (*135* impr.)
Acres artificially drained, 7,334,404 (25.6% imp. farm land)
Acres needing drainage, 2,052,942 (6.1% all farm land)
Farms by size, number:
Up to 19 acres.....................11,521; *13,724*
20 " 49 " .....................13,117; *15,678*
50 " 99 " .....................35,959; *38,712*
100 " 174 " .....................85,549; *80,121*
175 " 499 " .....................65,279; *66,165*
Over 500 " ..................... 2,014; *2,644*
Value all farm property...$8,524,870,956; *$3,745,860,544*
Per cent increase in ten years.................127; *136*
Value farm land.........$6,679,020,577; *$2,801,973,729*
" " buildings..... $922,751,713; *$455,405,671*
" " implements... $309,172,398; *$95,477,948*
" " livestock..... $613,926,268; *$393,003,196*
Av. value all property per farm........$39,941; *$17,259*
" " land and buildings per acre......$227.09; *$96*
Farms run by owners, 121,888 (51.9%); *133,008 (61.2%)*
Farms run by tenants 89,064 (41.7%); *82,115 (37.8%)*
Per cent owned farms unmortgaged..........37.6; *47.5*
Per cent farms reporting automobiles 73.1; telephones 86.1

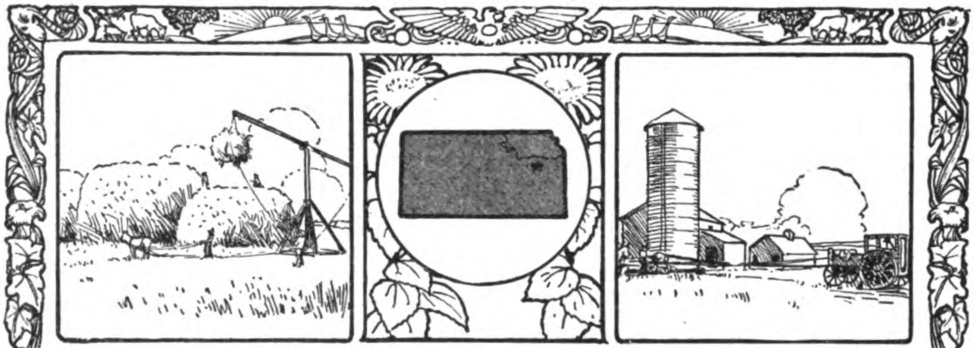
**2. Crop Acreages, Yields, Values, 1919 and *1909***

Value all farm crops.........$890,391,299; *$309,376,240*
" " cereals............$696,022,846; *$230,205,315*
Corn, acres.............. 9,006,733; *9,229,378*
production (bu.).... 371,362,393; *341,750,460*
10-yr. av. yield per acre..............37.3 bu.
Wheat, acres............ 1,437,743; *526,777*
production (bu.).... 21,591,928; *8,055,944*
10-yr. av. yield per acre................18 bu.
Oats, acres.............. 5,484,113; *4,655,154*
production (bu.).... 187,045,705; *128,198,055*
10-yr. av. yield per acre..............37.7 bu.
Rye, acres.............. 89,458; *42,042*
production (bu.).... 1,110,739; *570,996*
10-yr. av. yield per acre................18 bu.
Barley, acres............ 236,314; *571,224*
production (bu.).... 5,352,802; *10,964,184*
10-yr. av. yield per acre..............28.4 bu.
Hay and forage, acres......................4,555,824
production (tons).....................9,327,772
value..............$146,959,888; *$59,395,318*
Potatoes, white, acres....... 97,336; *169,567*
production (bu.).... 4,438,515; *14,710,247*
10-yr. av. yield per acre................78 bu.
Buckwheat, acres........... 6,956; *9,066*
production (bu.).... 99,587; *120,559*
Sorghum, acres............ 9,698; *4,996*
production (tons)... 45,340; *24,597*
Maple sugar, trees tapped.... 19,838; *23,965*
sugar made (lbs.) ... 3,130; *6,173*
Small fruits, acres.......... 7,885; *7,211*
production (quarts) 8,837,293; *10,344,052*
Vegetables, acres 73,372; value $28,305,846; *$12,021,408*
Apples, production (bu.)..... 1,810,443; *6,746,668*
Pears, production (bu.)...... 30,036; *44,449*
Peaches, production (bu.).... 1,891; *23,180*
Plums and prunes, (bu.) ..... 27,929; *158,036*
Grapes, production (lbs.).... 12,165,318; *11,708,336*
Forest products, value....... $4,404,555; *$3,649,032*
Nurseries: no. 194; acres, 2,158; receipts.......$532,399

Greenhouses: sq. ft. under glass, 3,663.189; receipts. . . . . . . . . . . . . . . . . . . . . . . . . .$2,059,773

3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 208,534; | pure breds 56,074 |
| Value all livestock on farms | $613,926,268; | *$393,003,196* |
| Horses, number | 1,386,522; | *1,492,226* |
| value | $127,297,231; | *$177,999,124* |
| Mules, number | 81,520; | *55,524* |
| value | $10,041,522; | *$7,551,818* |
| All cattle, number | 4,557,708; | *4,448,006* |
| value | $258,677,963; | *$118,864,139* |
| Beef cattle, number | | 3,038,198 |
| Dairy cattle, number | 1,519,510; | *1,492,226* |
| Sheep, number | 1,092,095; | *1,145,549* |
| Sheep, value | $12,883,597 | *$5,748,836* |
| Goats, number | 10,526; | *20,664* |
| value | $59,594; | |
| Swine, number | 7,864,304; | *7,545,852* |
| value | $176,264,026; | *$69,693,213* |
| Poultry, number | 28,352,515; | *23,482,888* |
| value | $27,779,633; | *$12,269,880* |
| Bees, number of hives | 138,319; | *160,021* |
| Livestock products, value | $130,250,447; | *$66,053,865* |
| Value all dairy products | $55,408,744; | *$31,196,889* |
| " eggs and chickens | $70,212,544; | *$33,150,583* |
| " wool and mohair | $3,765,909; | *$1,420,975* |
| " honey and wax | $863,250; | *$285,422* |
| Milk produced (gallons) | 361,426,362; | *318,954,509* |
| Butter made (lbs.) | 25,422,675; | *38,679,566* |
| Eggs produced (dozens) | 120,967,319; | *108,662,888* |



# KANSAS

**KANSAS** ("Sunflower State"), a North Central State, is situated between 37 and 40 degrees north latitude, and 94 and 103 degrees west longitude. The northern part of the east boundary is the Missouri River. Area, 82,158 square miles, 384 of which are water.

Land surface. Kansas is a prairie state. Nearly the entire surface is an undulating plain which slopes gradually from nearly 4,000 feet elevation in the west to 750 to 1,000 feet in the east and south. High bluffs are found along many of the rivers, those along the Missouri being more than 200 feet. The Arkansas River drains the southern part; its chief branches are the Cimarron, Verdigris and Neosho. Chief branches of the Kansas in the north are Big Blue, Republican, Solomon and Smoky Hill. There are few forests, but tree planting has been done to some extent by the Federal Government.

Soils. These are chiefly silt loams. Those of the northeastern part have been formed by glacial action, and are quite fertile; those of the southeastern part are residual shale and sandstone and are not especially fertile; throughout the central and east central parts the soils are residual, chiefly from limestone, and quite productive; in the northwestern section they are of loessial formation, very high in plant food content but of limited productivity because of light rainfall. The soils of the southwestern corner (where the sand dunes are found) have been derived from outwash material from the Rocky Mountains. The quite extensive river bottom soils are mainly sandy loams and are decidedly fertile.

Climate. The average annual temperature for the state is 54 degrees. The winters are generally mild and the hottest summer days are tempered by cool evenings. Temperatures vary considerably from north to south, also because of altitude, from east to west. Highest recorded temperature for the north is 115 degrees at Manhattan; lowest, 36 degrees below zero at Superior. For the south, highest, 114 degrees at Winfield; lowest, 32 degrees below at Garden City. The extremes are rare. The frost-free season in the southeast is more than 200 days; in the northwest, 155 days. Rainfall has varied widely in different years, but the larger part usually falls during the growing season. It ranges from an average of 16 inches in the west to 44 inches in the east. Snowfall varies from 11 inches to 52 inches in different parts of the state, and also varies greatly from year to year. The state has suffered in some seasons from severe droughts. Tornadoes are not unknown, especially in the central and southern parts of the state; they usually cause but little destruction and affect only small territories.

Opportunities. Irrigation renders highly productive regions otherwise barren in the semi-arid western third of the state. So far, these are mainly in the Arkansas Valley, where an abundant supply of underground

water, available at depths varying from 20 to 150 feet, is being profitably brought to the surface by steam and electric pumps. There are also numerous flowing wells.

**Products and industries.** Leading farm activities are the production of cereals, hay and forage, vegetables, fruits and livestock. Corn is the leading crop in the east. Through the center of the state, from north to south, is the wheat belt; hard winter wheat, famous for its milling qualities, is largely grown. Oats, rye and barley are important crops in the north and east. Potatoes, sweet potatoes and other vegetables are successfully grown in the south and east. Broom corn, sorghum, millet, kafir and flax should also be mentioned. Alfalfa holds a high place among the forage crops, and sugar beet growing is important in the southwestern part. The western part is largely grazing country, although much former grazing land is gradually being brought under cultivation for wheat. Large numbers of range cattle are fattened further east in the alfalfa and corn country. Swine are produced in large numbers, and many horses and mules. Dairying is being extended, and poultry is important. Fruit growing is increasing; apples lead, being especially important in the northern and eastern sections. Pears, plums, peaches, and cherries also do well throughout most of the state. Grapes and small fruits thrive—many of the latter being native to the state. Leading minerals are coal, petroleum and natural gas, zinc, lead, limestone and salt. The manufactures are largely of agricultural products. Slaughtering and meat packing lead, followed by flouring, railroad-shop construction, zinc smelting, printing, and butter, cheese and condensed milk manufacturing.

**Transportation and markets.** Railway communication is exceptionally good in all directions. Several transcontinental lines give outlets east and west and others to the south and Gulf ports. The Missouri River on the northeast furnishes the only water communication. Kansas City is the leading market and largest city; population, 1910, 82,331.

**History.** Named for the Kansas Indians. Coronado, a Spanish explorer, first visited the region in 1541, and the French explored it in 1719. The Lewis and Clark expedition traversed the state in 1804. A military post was established at Fort Leavenworth in 1827. Kansas was set off from Missouri territory in 1854. After a long and bitter struggle between anti-slavery and pro-slavery forces, Kansas was admitted as a free state in 1861. Capital, Topeka; population, 1910, 46,747.

**Agricultural organization.** College of Agriculture and Experiment Station, *Manhattan;* Branch Stations, *Tribune, Fort Hays, Garden City.* Coöperative Demonstration Work, *Hays, Parsons, Dodge City, Norton.* There are a State Grange, Farmers' Union, Board of Agriculture, Horticultural Society, Improved Stock Breeders' Association, Dairy Association, State Fair Association, Stallion Registration Board.

### Statistics

#### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 1,769,257; | *1,690,949* |
| City | 617,964 (34.9%); | 493,790 (29.2%) |
| Country | 1,151,293 (65.1%); | *1,197,159 (70.8%)* |
| Number of farmers | 165,286; | *177,841* |
| White | 153,048 (99.3%); | *175,150 (99%)* |
| Non-white | 1,238 (.7%); | *1,691 (1.%)* |
| Land area, acres | 52,335,360 | |
| Acres in farms | 45,425,179; | *43,384,799* |
| Acres farm land improved | 30,600,760; | *29,904,067* |
| Average acres per farm | 274 (186 impr.); | *244 (168* impr.) |
| Acres artificially drained | 106,985 (.3% impr. farm land) | |
| Acres needing drainage | 68,292 (.2% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 7,330; | *8,042* |
| 20 " 49 " | 8,277; | *10,738* |
| 50 " 99 " | 20,287; | *26,151* |
| 100 " 174 " | 49,044; | *57,789* |
| 175 " 499 " | 64,047; | *61,286* |
| Over 500 " | 16,301; | *13,835* |
| Value all farm property | $3,302,806,187; | *$2,039,389,910* |
| Per cent increase in ten years | 61.1; | *136* |
| Value farm land | $2,475,635,172; | *$1,537,976,573* |
| " " buildings | $354,428,746; | *$199,579,599* |
| " " implements | $154,716,977; | *$48,310,161* |
| " " livestock | $318,025,292; | *$253,523,577* |
| Av. value all property per farm | $19,982; | *$11,467* |
| " " land and buildings per acre | $62.30; | *$40.05* |
| Farms run by owners | 97,090 (58.8%); | *111,108 (62.4%)* |
| Farms run by tenants | 66,701 (40.4%); | *65,398 (36.8%)* |
| Per cent owned farms unmortgaged | 42.2; | *54.5* |
| Per cent farms reporting automobiles 6.2; telephones 77.9 | | |

#### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $588,923,248; | *$212,218,933* |
| " " cereals | $457,902,638; | *$169,109,449* |
| Corn, acres | 3,676,074; | *8,109,061* |
| production (bu.) | 59,719,831; | *154,651,703* |
| 10-yr. av. yield per acre | | 16.2 bu. |
| Wheat, acres | 11,266,664; | *5,973,785* |
| production (bu.) | 148,475,729; | *77,577,115* |
| 10-yr. av. yield per acre | | 14 bu. |
| Oats, acres | 1,415,928; | *933,309* |
| production (bu.) | 36,257,356; | *22,923,641* |
| 10-yr. av. yield per acre | | 26.2 bu. |
| Rye, acres | 190,506; | *17,179* |
| production (bu.) | 1,906,768; | *160,415* |
| 10-yr. av. yield per acre | | 14.5 bu. |
| Barley, acres | 423,033; | *166,115* |
| production (bu.) | 8,324,783; | *2,221,816* |
| 10-yr. av. yield per acre | | 18 bu. |
| Hay and forage, acres | 5,000,066; | *3,957,745* |
| production (tons) | 8,504,534; | *5,936,997* |
| value | $105,123,767; | *$32,174,632* |
| Potatoes, white, acres | 47,246; | *79,025* |
| production (bu.) | 3,014,845; | *5,647,049* |
| 10-yr. av. yield per acre | | 63 bu. |
| Sweet, acres | 4,366; | *4,883* |
| production (bu.) | 448,986; | *558,021* |
| 10-yr. av. yield per acre | | 95 bu. |
| Buckwheat, acres | 233; | *756* |
| production (bu.) | 1,695; | *8,114* |
| Small fruits, acres | 3,578; | *5,400* |
| production (quarts) | 3,553,202; | *5,477,274* |
| Strawberries, acres | 1,188; | *1,719* |
| production (quarts) | 1,828,104; | *2,119,048* |
| Vegetables, acres 11,944; value | $15,786,842; | *$6,808,653* |
| Apples, production (bu.) | 1,749,293; | *1,356,438* |
| Pears, production (bu.) | 221,487; | *19,412* |
| Peaches, production (bu.) | 215,564; | *24,567* |
| Plums and prunes (bu.) | 33,346; | *12,250* |
| Grapes, production (lbs.) | 5,310,044; | *6,317,684* |
| Forest products, value | $1,572,077; | *$1,366,950* |
| Nurseries: no. 81; acres 1,059; receipts | $290,470 | |
| Greenhouses: sq. ft. of glass 2,230,752; receipts, $957,518 | | |

#### 3. Livestock, 1920 and *1910*

Farms reporting livestock....160,739; pure breds 26,771

| | | |
|---|---|---|
| **Value all livestock on farms** | $318,025,292; | *$253,523,577* |
| Horses, number | 1,082,827; | *1,147,056* |
| value | $84,383,872; | *$112,758,180* |
| Mules, number | 99,847; | *83,405* |
| value | $29,332,669; | *$25,629,418* |
| All cattle, number | 2,975,390; | *3,079,403* |
| value | $154,004,831; | *$80,557,443* |
| Beef cattle, number | | 2,045,637 |
| Dairy cattle, number | 929,753; | *736,107* |
| Sheep, number | 361,102; | *272,475* |
| value | $4,165,722; | *$1,209,931* |
| Goats, number | 6,937; | *8,847* |
| value | $40,529; | |

| | | |
|---|---|---|
| Swine, number | 1,733,202; | *3,000,157* |
| value | $29,400,418; | *$24,706,885* |
| Poultry, number | 17,298,041; | *15,736,038* |
| value | $15,453,540; | *$7,377,469* |
| Bees, number of hives | 81,337; | *73,737* |
| Livestock products, value | $80,322,550; | *$36,681,450* |
| Value all dairy products | $34,920,619; | *$13,091,739* |
| " eggs and chickens | $44,199,844; | *$23,246,574* |
| " wool and mohair | $1,020,650; | *$258,700* |
| " honey and wax | $181,437; | *$84,437* |
| Milk produced (gallons) | 221,454,417; | *172,742,767* |
| Butter made (lbs.) | 13,761,085; | *25,986,931* |
| Eggs produced (dozens) | 76,136,616; | *81,087,689* |

# KENTUCKY

**KENTUCKY** ("Blue Grass State"), one of the South Central States, is situated between 36 and 40 degrees north latitude, and 82 and 90 degrees west longitude. Its boundaries are largely rivers, the Ohio and Big Sandy forming the northern boundary and the Mississippi the southwestern. Area, 40,598 square miles, of which 417 are water.

Land surface. Kentucky has a greatly diversified surface. There are 5 well-defined regions, each differing in elevation, soil and climate. The mountainous section of the southwest has some elevations of 3,000 feet; in the eastern and southeastern part is the plateau region with elevations of 1,000 to 1,500 feet; in the northeast is the "Blue Grass Region" of gently rolling land with an elevation of about 1,000 feet; low foot-hills in the south have an elevation of 400 to 600 feet; high plateaus and hill country in the north reach from 600 to 1,200 feet. The state drains into the Mississippi River which flows for a distance along the southwestern boundary. The general slope is towards the west and northwest. It has numerous natural caverns or caves, the best-known of which is the well-known Mammoth Cave.

Soils. The soil is largely limestone; that of the northwest is a mixture of limestone and sandstone which somewhat lessens its fertility. In the south and west are some clay soils and along the rivers typical alluvial formations. Much of the loamy limestone soil is underlaid with clay. A large part of the state is well fitted for diversified agriculture, some of it for special crops.

Climate. The average annual temperature varies from about 50 degrees in the Cumberland Mountains in the southeast to 60 degrees along the Mississippi in the southwest. The climate generally is mild. Highest recorded temperature in the east is 108 degrees at Lexington and Maysville; lowest 28 degrees below zero at Shelby City. In the western section, the highest temperature was 112 degrees at Paducah; lowest 30 below zero at Loretto. The average frost-free season in western Kentucky is 180 days; in the eastern part a little less. Average rainfall of the state 44 inches, heaviest in the Cumberland River basin, lightest in the Licking River basin. The state is within the normal storm tracks from the southwest, and rainfall is generally well distributed, the least being in September and October.

Opportunities. Information about agricultural opportunities may be obtained from the Agricultural Experiment Station, Lexington.

Products and industries. Leading farm activities are the production of cereals, tobacco, fruits, livestock and a variety of miscellaneous crops. Corn is the leading grain; others in order are wheat, oats and rye. Great quantities of hay are produced, and this with the corn and oats contributes to a large production of fine horses, in which line the state has long been a leader. Their value far exceeds that of any other livestock. Tobacco is large-

ly grown in the western central part along the rivers, and the state leads in this product. Kentucky raises about nine tenths of the hemp fiber of the country. Cotton, sorghum, potatoes, sweet potatoes and watermelons are extensively grown. Apples, peaches, pears and other tree fruits, grapes and small fruits are increasingly produced. Dairying and sheep raising, for which the state is admirably adapted, are increasing. Large quantities of poultry are produced. Lumbering is carried on to a considerable extent. River fisheries are extensive. Leading minerals are coal, iron, fluorspar, limestone and petroleum; clay, sandstone, limestone and cement are also important. Manufactures in order of their importance are flour, lumber and planing-mill products, tobacco, clothing, iron and steel, cars, meat products, foundry products.

**History.** Originally a part of Aŭgusta County, Virginia, Kentucky was formed into a separate county in 1776. First settlement at Harrodsburg, 1774. A fort was built on present site of Boonesboro by Daniel Boone, 1775. In 1780, Kentucky was divided into 3 counties, and in 1789, separated from Virginia. Admitted into the Union in 1792. The Kentucky Governor wished to remain neutral at the outbreak of the Civil War, but elections in 1861 showed that the people favored the Union cause, and the state remained in the Union.

**Agricultural organization.** College of Agriculture and Experiment Station; Coöperative Demonstration Work, *Lexington*; Industrial and Normal Institute for Colored Persons, *Frankfort*; Board of Agriculture, *Frankfort*; State Grange, Beef Cattle Breeders' Association, Dairy Cattle Club, Corn Growers' Association, Horticultural Society, Burley Tobacco Society, Trotting Horse Breeders' Association, Poultry Association, Duroc-Jersey Association, Berkshire Association, Sheep Breeders' Association, Swine Breeders' Association, State Fair Association.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population..........2,416,630; *2,289,905*
City........633,543 (26.2%); *555,442 (24.3%)*
Country..1,783,087 (73.8%); *1,734,463 (75.7%)*
Number of farmers..........270,625; *259,185*
White.......257,998 (95.3%); *247,455 (95.5%)*
Non-white.......12,628 (4.7%); *11,730 (4.5%)*
Land area, acres..........25,715,840
Acres in farms..........21,612,772; *22,189,127*
Acres farm land improved ........13,975,746; *14,354,471*
Average acres per farm. .79 (52 impr.); *85.6 (55.4* impr.)
Acres artificially drained 225,228 (1.6% impr. farm land)
Farm land needing drainage. 573,299 (2.7% all farm land)
Farms by size, number:
Up to 19 acres..........58,965; *55,472*
20 " 49 " ..........63,571; *58,537*
50 " 99 " ..........71,200; *65,778*
100 " 174 " ..........50,991; *50,134*
175 " 499 " ..........28,843; *26,639*
Over 500 " .......... 2,056; *2,625*
Value all farm property....$1,511,901,077; *$773,797,880*
Per cent increase in ten years..........95.3; *64.3*
Value farm land..........$1.050,752,680; *$484,464,617*
" " buildings....... $254,406,256; *$150,994,755*
" " implements.... $48,354,857; *$20,851,846*
" " livestock....... $158,387,284; *$117,486,662*
Av. value all property per farm..........$5,587; *$2,986*
" " land and buildings per acre.....$60.39; *$28.64*
Farms run by owners 179,327 (66.6%); *170,332 (65.7%)*
Farms run by tenants 90,330 (33.4%); *87,860 (33.9%)*
Per cent owned farms unmortgaged..........65; *79.6*
Per cent farms reporting automobiles 10.5; telephones 27

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops..........$347,338,888; *$130,594,808*
" " cereals..........$151,792,740; *$66,738,651*
Corn, acres.......... 3,247,167; *3,436,340*
production (bu.).... 71,518,484; *83,348,024*
10-yr. av. yield per acre..........27.3 bu.
Wheat, acres.......... 839,987; *681,323*
production (bu.).... 10,375,129; *8,737,260*
10-yr. av. yield per acre..........12 bu.
Oats, acres.......... 229,464; *174,315*
production (bu.).... 2,791,447; *2,406,064*
10-yr. av. yield per acre..........22.9 bu.
Rye, acres.......... 27,678; *26,813*
production (bu.).... 240,555; *255,532*
10-yr. av. yield per acre..........12.4 bu.
Cotton, acres.......... 5,355; *7,811*
production (bales).. 2,967; *3,469*
Hay and forage, acres..........2,084,909
production (tons)..........2,123,490
value.......... $43,399,964; *$10,510,422*
Potatoes, white, acres....... 50,069; *55,750*
production (bu.).... 3,131,377; *5,120,141*
10-yr. av. yield per acre..........78 bu.
Sweet, acres .......... 14,892; *11,882*
production (bu.).... 1,222,651; *1,326,245*
10-yr. av. yield per acre..........96 bu.
Tobacco, acres.......... 634,038; *469,795*
production (lbs.).... 506,150,592; *398,482,301*
10-yr. av. yield per acre..........858 lbs.
Sorghum, acres.......... 49,968; *52,858*
production (tons)... 154,963; *198,404*
Small fruits, acres.......... 6,163; *4,387*
production (quarts). 5,323,010; *4,972,702*
Strawberries, acres.......... 3,112; *1,553*
production (quarts). 3,194,624; *2,114,929*
Vegetables, acres 16,124; value $26,163,576; *$11,850,994*
Apples, production (bu.)..... 1,280,549; *7,368,499*
Pears, production (bu.)...... 54,764; *251,536*
Peaches, production (bu.).... 459,681; *1,623,379*
Plums and prunes, (bu.)..... 68,317; *139,346*
Grapes, production (lbs.).... 1,497,769; *3,680,182*
Forest products, value....... $16,606,621; *$7,843,142*
Nurseries; acres 230 in 47 establishments; receipts $67,245
Greenhouses: sq. ft. under glass 1,662,532;
receipts..........$718,453

### 3. Livestock, 1920 and *1910*

Farms reporting livestock.. 253,144; pure breds 11,379
Value all livestock on farms..$158,387,284; *$117,486,662*
Horses, number.......... 382,442; *443,034*
value.......... $37,075,671; *$44,786,160*
Mules, number.......... 292,857; *225,043*
value.......... $35,381,809; *$26,402,090*
All cattle, number.......... 1,093,453; *1,000,937*
value.......... $52,291,343; *$25,971,571*
Beef cattle, number..... 433,659;
Dairy cattle, number.... 659,794; *409,834*
Sheep, number.......... 707,845; *1,363,013*
value.......... $7,905,169; *$5,573,998*
Goats, number.......... 35,045; *29,869*
value..........$125,047
Swine, number.......... 1,504,431; *1,491,816*
value.......... $15,471,514; *$8,951,692*
Poultry, number.......... 11,020,231; *8,764,204*
value.......... $7,256,725; *$4,461,871*
Bees, number of hives..... 156,889; *152,991*
Livestock products, value.... $50,928,217; *$24,776,564*
Value all dairy products... $22,487,710; *$9,055,813*
" eggs and chickens... $26,210,759; *$14,542,124*
" wool and mohair.... $1,775,201; *$976,385*
" honey and wax.... $454,547; *$202,242*
Milk produced (gallons)... 146,561,464; *125,566,917*
Butter made (lbs.)........ 34,080,415; *38,130,687*
Eggs produced (dozens).... 42,224,720; *43,871,616*

# LOUISIANA

**LOUISIANA** ("Creole State") a Gulf State, lies between 28 and 33 degrees north latitude, and 89 and 94 degrees west longitude. The Mississippi and Pearl Rivers form most of the eastern boundary, and the Sabine River a large part of the western. Other rivers within the state are the Red, Ouachita, and Pearl. Area, 48,506 square miles of which about 3,097 are water surface. The state has a coast of very irregular outline, and many outlying islands.

**Land surface.** Approximately 36 per cent of the area is hill land, 30 per cent alluvial or bottom lands, 8 per cent high prairie, 7 per cent "bluff," 4 per cent pine flats, 3 per cent lakes and 12 per cent flat prairie and coast marsh. The hill lands vary from gentle undulations to rather steep hills reaching in the north central portion of the state an elevation of 484 feet. The hill section west of the Mississippi River extends from the west bank of the Ouachita River to the western border of the state, a distance of about 125 miles, and from the Louisiana-Arkansas line southward an extreme distance of about 185 miles, forming a broad V-shaped area. The alluvial formation of the Red River cuts through this territory diagonally from the northwest corner to the southeast, with a width varying from 2 to 20 miles. About one-half of the area east of the Mississippi River and north of Lake Pontchartrain is also hill land. The prairie region occupies the central southern portion of the state with a belt extending westward to the state line, with an elevation not often exceeding 50 feet above sea level. The greater portion of the "bluff" area is adjacent to the east bank of the Mississippi River, from Baton Rouge to the Mississippi state line, and to the west bank of the Bayou Mason in north Louisiana, though a broken belt extends from the Bayou Mason ridge to the Gulf. This formation is often cut into deep ravines near the streams, but otherwise is of gently rolling surface, or almost flat. "Pine flats" are level stretches of pine forests bordering the hill lands in the southeastern and the southwestern portions of the state. The alluvial lands have been formed from the deposits of the sediment-carrying streams. The flood plains of the Mississippi, Red, Ouachita and Atchafalaya Rivers constitute the more important areas of this formation. The banks of the streams are the highest elevations. Some of the alluvial lands of the Red and the Ouachita Rivers are above the crest of the highest flood waters, but the remaining territory is protected from overflow during flood periods by earth embankments or levees along the banks of the streams.

Soils. There are several varieties of soils in each formation. Sandy loams and sandy soils prevail in the hill lands, of moderate fertility, respond readily to fertilizers, and are easily cultivated. In the alluvial sections, the areas nearest the streams are generally sandy, or sandy loams, gradually blending into stiff silt soils of the lower levels, all very fertile. The bluff soils vary widely, but light silt and clay loams predominate, less fertile than the alluvial, more fertile than the hill. The pine flats are generally regarded as poor soils, though with good surface drainage and heavy fertilization, they produce large yields of early truck crops. Prairie soils generally overlie a hard pan, rendering these regions especially suited for irrigating rice crops with a minimum amount of water. They are better suited to rice and small grains than to general farming.

Climate. The climate is mild, even subtropical, in the extreme southern portion. Occasionally sudden changes in temperature occur during the winter months, and though low temperatures are of short duration, they seem colder than the thermometer would indicate. Freezing temperatures are likely to extend to the Gulf at any time during the winter months, though some win-

ters pass without such freezes. The highest temperatures ordinarily experienced in summer are about 96 degrees in the southern portion, and 98 in the northern portion. Gulf breezes temper the climate to a distance of almost 150 miles inland. The average frost-free season is about 8 months for the northern, 9 months for the southern portion of the state. The average annual rainfall is about 70 inches for New Orleans and 45 in Shreveport, with intermediate average for intermediate areas. Rainfall is generally well distributed. Complete crop failures are unknown.

**Opportunities.** There are no public lands valuable for agricultural purposes. Much public land has recently become valuable because of the discoveries of oil and gas on or near them. Land offices are at Baton Rouge.

**Products and industries.** Leading farm activities are the production of sugar cane, cotton and rice, with corn the leading cereal, and the production of vegetables for northern markets, sweet and Irish potatoes, fruits and livestock. Louisiana leads in the production of sugar cane and rice, but corn, sugar and cotton have each held the place of greatest value in recent years. Rice is largely grown on the prairie soils toward the western border, much being irrigated from wells by pumping. Hay and oats are important crops. Some orchard fruits are grown in the north, and subtropical fruits in the south, but the most important small fruit is the strawberry. Special trains are operated for transporting the strawberry crop of Tangefeboa Parish during the high productive portion of the season. Blackberries and dewberries are abundant in uncultivated lands. Grapes do well if sprayed for protection against black rot. Potatoes and sweet potatoes thrive. Pecan orcharding is becoming an important industry. Livestock growing is increasing. Dairying is important. Lumbering is extensive, its products ranking second in value in the United States. Fisheries employ many men, with considerable capital invested. The state ranks first in the United States in the production of furs. The oyster and shrimp fisheries supply several large canning factories, as well as an extensive fresh trade throughout the south and central states, distant shipments being made under refrigeration. Leading minerals are petroleum, gas, sulphur, salt. Main manufactures are sugar, sirup, and molasses, canned foods (oysters, shrimp, vegetables), lumber and timber, cottonseed oil and cake, cleaned and polished rice, bags, bakery products, malt liquors, foundry products, copper, tin, and sheet-iron products, turpentine and resin, wood distillates, paper and refined petroleum products.

**Transportation and markets.** Louisiana is well covered by railroads. In his report for 1916, the Commissioner of Agriculture and Immigration says: "Four or 5 years ago, there were but few miles of hard-surface roads in the state. Today there are 1,014 miles, and millions of dollars have been appropriated for a continuation of the work." A large part of the state is accessible by river steamboats. The Gulf of Mexico gives an outlet for coastwise and export shipping. New Orleans is the second largest port in the United States, and an excellent market. Shreveport, Baton Rouge, Alexandria, Monroe and Lake Charles are other leading cities.

**History.** Louisiana was first explored by the Spaniards in 1519 to 1541. In 1682, La Salle took possession in the name of the King of France, Louis XIV. It became an independent colony in 1711. New Orleans was founded in 1718, made the capital in 1722. Became a royal province in 1731. After various changes and revolts, in 1803, Louisiana was purchased by the United States from France. In 1804, organized as Territory of Orleans; in 1812 admitted as a state, which seceded in 1861. In 1852 the capital was removed to Baton Rouge (population, 1910, 14,897).

**Agricultural organization.** Agricultural and Mechanical College and Experiment Station, Commissioner of Agriculture and Immigration; State Livestock Sanitary Board, State Counsel of Defense, all *Baton Rouge*. Sugar Station, *Audubon Park;* North Louisiana Station, *Calhoun;* Rice Station, *Crowley;* Southern University and A. & M. College, Scotland Heights, *Baton Rouge*. Louisiana Dairymen's Association; Louisiana Swine Breeders' Association, Louisiana Jersey Breeders' Association; Louisiana Holstein Breeders' Association; Louisiana Horticultural Society; Louisiana Sugar Planters' Association, Louisiana Cane Growers' Association, Louisiana Rice Growers' Association. State Fair held at *Shreveport*.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | |
|---|---|
| Population | 1,798,509; *1,656,388* |
| City | 628,163 (34.9%); *496,516 (30%)* |
| Country | 1,170,346 (65.1%); *1,159,872 (70%)* |
| Number of farmers | 135,463; *120,546* |
| White | 73,404 (54.2%); *65,694 (54.5%)* |
| Non-white | 62,059 (45.8%); *54,879 (45.5%)* |
| Land area, acres | 29,061,760 |
| Acres in farms | 10,019,822; *10,439,481* |
| Acres farm land improved | 5,626,226; *5,276,016* |
| Average acres per farm | 73.9 (39 impr.); *86.6 (43* impr.) |
| Acres artificially drained | 1,004,935 (17.9% impr. farm land) |
| Acres needing drainage | 1,095,769 (10.9% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 30,033; *29,256* |
| 20 " 49 " | 61,346; *46,389* |
| 50 " 99 " | 21,715; *20,248* |
| 100 " 174 " | 12,855; *13,681* |
| 175 " 499 " | 7,472; *8,406* |
| Over 500 " | 2,042; *2,566* |
| Value all farm property | $589,826,679; *$301,220,988* |
| Per cent increase in ten years | 95; *51.7* |
| Value farm land | $383,618,162; *$187,803,277* |
| " farm buildings | $90,420,631; *$49,741,173* |
| " " implements | $32,715,010; *$18,977,053* |
| " " livestock | $83,072,876; *$44,699,485* |

| | | |
|---|---|---|
| Av. value all property per farm | $4,354; | *$2,499* |
| " " land and buildings per acre | $47.31; | *$22.75* |
| Farms run by owners | 57,254 (42.2%); | *52,989 (43.9%)* |
| Farms run by tenants | 77,381 (57.1%); | *66,607 (55.3%)* |
| Per cent owned farms unmortgaged | 62.9; | *79.3* |
| Per cent farms reporting automobiles 7.; telephones 6.3 | | |

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value all farm crops | $206,182,548; | *$73,536,538* |
| " " cereals | $80,166,279; | *$24,786,984* |
| Corn, acres | 1,504,970; | *1,590,830* |
| production (bu.) | 21,675,602; | *26,010,361* |
| 10-yr. av. yield per acre | | 19 bu. |
| Oats, acres | 33,443; | *29,711* |
| production (bu.) | 489,380; | *420,033* |
| 10-yr. av. yield per acre | | 22.3 bu. |
| Cotton, acres | 1,343,334; | *957,011* |
| production (bales) | 306,791; | *268,909* |
| 10-yr. av. yield per acre | | 163 lbs. |
| Hay and forage, acres | 208,631; | *180,811* |
| production (tons) | 278,556; | *245,815* |
| value | $7,083,068; | *$2,446,391* |
| Potatoes, white, acres | 19,677; | *19,655* |
| production (bu.) | 971,705; | *1,183,525* |
| 10-yr. av. yield per acre | | 67 bu. |
| Sweet, acres | 68,033; | *56,953* |
| production (bu.) | 5,324,419; | *4,251,086* |
| 10-yr. av. yield per acre | | 87 bu. |
| Peanuts, acres | 17,670; | *25,020* |
| production (bu.) | 262,888; | *412,037* |
| Sugar cane, acres | 234,049; | *329,684* |
| production (tons) | 2,435,683; | *4,941,996* |
| Rice, acres | 456,959; | *317,518* |
| production (quarts) | 5,342,180; | *6,420,207* |
| Strawberries, acres | 4,007; | *3,570* |
| production (quarts) | 5,323,890; | *6,405,236* |
| Vegetables, acres 11,668; value | $19,297,120; | *$6,282,904* |
| Apples, production (bu.) | 43,910; | *33,875* |
| Pears, production (bu.) | 58,640; | *35,554* |
| Peaches, production (bu.) | 381,863; | *290,623* |
| Plums and prunes (bu.) | 41,683; | *31,473* |
| Grapes, production (lbs.) | 67,203; | *106,595* |
| Forest products, value | $5,450,619; | *$3,584,340* |
| Nurseries: no. 35; acres 335; receipts | | $101,097 |
| Greenhouses: sq. ft. of glass 301,004; receipts | | $150,323 |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Farms reporting livestock | 125,648; | pure breds 3,807 |
| Value all livestock on farms | $83,082,876; | *$44,699,485* |
| Horses, number | 178,756; | *181,286* |
| value | $15,709,070; | *$11,789,695* |
| Mules, number | 180,115; | *131,554* |
| value | $28,348,039; | *$15,624,962* |
| All cattle, number | 804,241; | *804,785* |
| value | $26,620,595; | *$11,605,354* |
| Beef cattle, number | 487,709; | |
| Dairy cattle, number | 316,532; | *279,097* |
| Sheep, number | 129,816; | *178,287* |
| value | $672,159; | *$343,046* |
| Goats, number | 91,249; | *57,102* |
| value | $229,940; | |
| Swine, number | 850,562; | *1,327,605* |
| value | $7,541,443; | *$3,824,046* |
| Poultry, number | 4,010,782; | *3,542,447* |
| value | $3,738,883; | *$1,326,614* |
| Bees, number of hives | 31,079; | *29,591* |
| Livestock products, value | $13,613,465; | *$7,286,958* |
| Value all dairy products | $4,509,985; | *$2,761,380* |
| " eggs and chickens | $8,835,402; | *$4,392,017* |
| " wool and mohair | $205,988; | *$99,650* |
| " honey and wax | $62,090; | *$33,911* |
| Milk produced (gallons) | 32,972,720; | *32,702,130* |
| Butter made (lbs.) | 4,252,318; | *6,232,006* |
| Eggs produced (dozens) | 13,136,046; | *14,423,023* |

# MAINE

**MAINE** ("Pine Tree State"), one of the New England States, and farthest north of the Atlantic States, is situated between 43 and 48 degrees north latitude, and 66 and 72 degrees west longitude. A number of rivers mark the boundary lines; the St. Francis and St. John on the north, the St. Croix on the east. Area 33,040 square miles, of which 3,145 are water surface.

**Land surface.** This is very irregular, being hilly to mountainous in the northwest, with a broad plateau covering most of the north central part. A central highland extends eastward across the state from about 46 degrees north latitude, about 1,500 feet high on the western border, to about 450 on the eastern. The country north of this highland drained by the St. John River is largely a forest dotted with lakes and swamps. South of the central highland the state slopes south and southeast and is drained by the St. Croix, Penobscot, Kennebec, Androscoggin and Saco Rivers. Hundreds of the state's 1,620 lakes are found here. The highest elevations are Mt. Katahdin in the central part, 5,200 feet; Mt. Bigelow, 3,600 feet, and Mt. Abraham, 3,388 feet, in the western part. The coast is very irregular with many bays; the headlands are mostly rocky and dangerous for vessels.

**Soils.** The soils are as varied as the sur-

face. Many of them are too poor and rocky for profitable cultivation. Along the rivers and about the lakes and between the Penobscot and Kennebec Rivers are very fertile alluvial soils. Along the seacoast is much sterile sand and clay. In the northern and northeastern part, in Aroostook County, is a large area of very fertile soil.

**Climate.** The climate is healthful but severe in winter. The ocean modifies the temperature considerably in the south, but the winters are long and snowfalls heavy. Temperatures vary considerably according to location and elevation, the annual average for the state being 43.6 degrees, varying from 41.1 degrees at Eastport and Mayfield to 45.4 degrees at Portland. Highest recorded temperature is 106 degrees at Millinocket; lowest 36 degrees below zero at several stations. Average annual rainfall, including snow, is 44.7 inches. Annual average snowfall is 81.3 inches. The frost-free season averages about 137 days, varying from 112 to 167 days at different stations. The summer and fall climates are especially delightful over most of the state.

**Opportunities.** Large areas are still in forest, and there is opportunity for pioneer work in lumbering and clearing the soil. Information about available land may be obtained from the Experiment Station at Orono.

**Products and industries.** Leading farm activities are the production of hay, oats and a few other cereals, sweet corn for canning, potatoes, apples, dairy products, and purebred dairy cattle, Ayrshires leading. Aroostook County is famed for the yields and quality of its potatoes and the successful raising of the crop is gradually being extended farther south, whence shipping rates are lower. Fine apples are grown in the southwestern part. Market garden crops, small fruits and poultry are produced in quantities to supply the many summer resorts. Immense quantities of wild blueberries are gathered. Lumbering is an important industry, the greater part of the state being still covered with forests. In fisheries, Maine ranks next to Massachusetts in capital invested and first in number of men engaged. Among the minerals, granite, limestone, marble, slate and clay products lead. Manufacturing enterprises are important and increasing on account of the abundant water power. Leading products are wood pulp, lumber and timber, cotton and woolen goods, boots and shoes, canned and preserved fish, vegetables and fruits, foundry and machine-shop products, flour, ships and leather. Chief manufacturing centers are Portland, Lewiston, Biddeford and Auburn. Bath is an important ship-building center.

**Transportation and markets.** The inhabited parts of the state are fairly well covered by railroads. There are also well-developed electric lines. The larger rivers are navigable for comparatively short distances, but the irregular coast line, about 2,000 miles long, provides many excellent harbors, from which lines of steamers run to Boston, New York and other market cities. The numerous summer resorts on the coast and inland also furnish excellent markets for all food products. Portland, Bangor and Eastport are ports of entry from which exports and imports are extensive.

**History.** Some explorations were made early in the sixteenth century and later, but not till the beginning of the next century were any settlements made, the first permanent one being at Pemaquid in 1625. Several other settlements were made along the coast during the next few years. Maine was a part of Massachusetts Territory until early in the eighteenth century. It was finally separated and admitted to the Union in 1820.

**Agricultural organization.** College of Agriculture and Experiment Station, *Orono*. Commissioner of Agriculture, Horticulturist, Bureau of Inspection, Livestock Sanitary Commissioner, all *Augusta*. Dairy Inspector, *Auburn;* Seed Improvement Work, *Brunswick;* Bureau of Marketing and Supplies, *Dexter*. There are the Dairymen's Association, Livestock Breeders' Association, Pomological Society, Poultry Association, Agricultural Fair Associations, State Grange, Farmers' Union.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 768,014; *742,371* |
| City | 299,569 (39%); *264,248 (35.3%)* |
| Country | 468,445 (61.%); *480,123 (64.7%)* |
| Number of farmers | 48,227; *60,016* |
| White | 48,214 (99.8%); *59,987 (99.8%)* |
| Non-white | 272 (.2%); *342 (.2%)* |
| Land area, acres | 19,132,800 |
| Acres in farms | 5,425,968; *6,296,859* |
| Acres farm land improved | 1,977,329; *2,360,657* |
| Average acres per farm | 112 (41 impr.); *104 (39* impr.) |
| Acres artificially drained | 26,302 (1.3% impr. farm land) |
| Acres needing drainage | 142,055 (2.6% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 4,525; *7,113* |
| 20 " 49 " | 6,768; *9,492* |
| 50 " 99 " | 14,277; *17,895* |
| 100 " 174 " | 14,425; *16,633* |
| 175 " 499 " | 7,683; *8,239* |
| Over 500 " | 549; *590* |
| Value all farm property | $270,526,733; *$199,271,998* |
| Per cent increase in ten years | 35; *62.8* |
| Value farm land | $14,411,871; *$86,481,395* |
| " " buildings | $189,697,100; *$73,138,231* |
| " " implements | $26,637,660; *$14,490,533* |
| " " livestock | $39,780,102; *$25,161,839* |
| Av. value all property per farm | $5,609; *$3,320* |
| " " land and buildings per acre | $37.62; *$25.35* |
| Farms run by owners | 45,437 (94.2%); *56,454 (94%)* |
| Farms run by tenants | 2,004 (4.2%); *2,563 (4.3%)* |
| Per cent owned farms unmortgaged | 67.5; *73.2* |
| Per cent farms reporting automobiles 24.2; telephones 49 | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $100,152,324; | *$33,386,440* |
| " " cereals | $5,616,507; | *$3,100,902* |
| Corn, acres | 6,965; | *15,213* |
| production (bu.) | 288,281; | *648,882* |
| 10-yr. av. yield per acre | | 44.9 bu. |
| Wheat, acres | 14,464; | *3,407* |
| production (bu.) | 261,185; | *85,119* |
| 10-yr. av. yield per acre | | 23 bu. |
| Oats, acres | 16,691; | *120,991* |

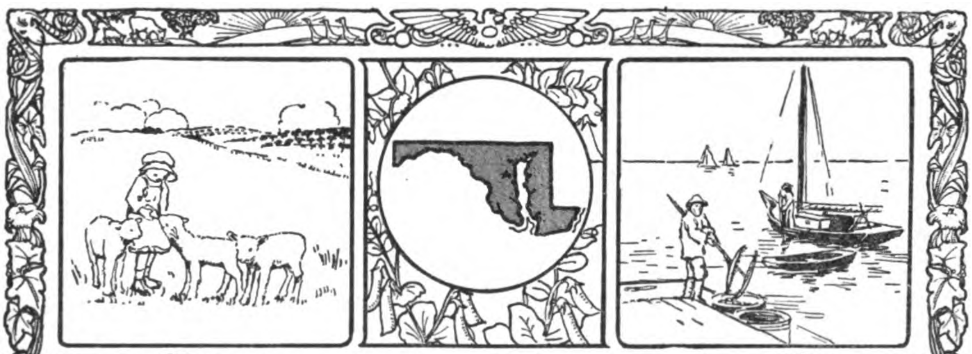
| | | |
|---|---|---|
| production (bu.) | 3,600,617; | *4,232,309* |
| 10-yr. av. yield per acre | 37.5 bu. | |
| Rye, acres | 272; | *292* |
| production (bu.) | 4,673; | *4,815* |
| Barley, acres | 4,358; | *4,136* |
| production (bu.) | 104,912; | *106,674* |
| 10-yr. av. yield per acre | 26.5 bu. | |
| Hay and forage, acres | 1,245,699; | *1,255,011* |
| production (tons) | 1,326,289; | *1,113,095* |
| value | $29,568,372; | *$15,118,195* |
| Potatoes, white, acres | 111,378; | *135,799* |
| production (bu.) | 25,531,470; | *28,556,837* |
| 10-yr. av. yield per acre | 199 bu. | |
| Buckwheat, acres | 14,364; | *15,552* |
| production (bu.) | 315,327; | *316,782* |
| 10-yr. av. yield per acre | 26.3 bu. | |
| Maple sugar, trees tapped | 234,478; | *252,764* |
| sugar made (lbs.) | 24,934; | *15,388* |
| syrup made (gal.) | 42,144; | *43,971* |
| Small fruits, acres | 1,573; | *1,260* |
| production (quarts) | 1,561,647; | *2,285,415* |
| Strawberries, acres | 555; | *698* |
| production (quarts) | 893,740; | *1,626,250* |
| Vegetables, acres 14,073; value | $57,681,901; | *$12,277,717* |
| Apples, production (bu.) | 4,829,346; | *3,636,181* |
| Pears, production (bu.) | 14,291; | *38,964* |
| Peaches, production (bu.) | 2,177; | *2,014* |
| Plums and prunes, (bu.) | 20,043; | *14,637* |
| Grapes, production (lbs.) | 100,789; | *231,529* |
| Forest products, value | $11,728,114; | *$5,573,763* |

Nurseries: acres 70 in 18 establishments; receipts $37,538

Greenhouses: sq. ft. of glass 714,580; receipts...$383,001

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Farms reporting livestock | 44,103; pure breds 4,912 | |
| Value all livestock on farms | $39,780,102; | *$25,161,839* |
| Horses, number | 94,350; | *107,574* |
| value | $15,980,681; | *$14,364,756* |
| Mules, number | 444; | *358* |
| value | $70,336; | *$72,446* |
| All cattle, number | 300,747; | *256,523* |
| value | $18,270,810; | *$7,784,384* |
| Beef cattle, number | 33,474; | |
| Dairy cattle, number | 267,273; | *156,819* |
| Sheep, number | 119,471; | *206,434* |
| value | $1,191,780; | *$813,976* |
| Goats, number | 476; | *582* |
| value | $3,809; | |
| Swine, number | 91,204; | *87,156* |
| value | $1,938,125; | *$948,094* |
| Poultry, number | 1,418,342; | *1,735,962* |
| value | $2,219,332; | *$1,131 921* |
| Bees, number of hives | 12,639; | *7,592* |
| Livestock products, value | $26,075,219; | *$13,613,815* |
| Value all dairy products | $17,772,370; | *$8,079,692* |
| " eggs and chickens | $7,815,871; | *$5,247,150* |
| " wool and mohair | $412,728; | *$266,287* |
| " honey and wax | $74,250; | *$20,686* |
| Milk produced (gallons) | 77,676,881; | *56,026,334* |
| Butter made (lbs.) | 10,855,560; | *13,299,229* |
| Eggs produced (dozens) | 9,977,349; | *14,876,215* |



# MARYLAND

**MARYLAND** ("Monumental State"), one of the South Atlantic States, lies between 37 and 40 degrees north latitude, and 75 and 80 degrees west longitude. The Potomac River forms most of its southern boundary. Chesapeake Bay, with the Susquehanna River flowing into it, divides the State into two parts. Area, 12,210 square miles of which 2,350 are water surface.

**Land Surface.** About two thirds of the eastern part of the State is in the Coastal Plain, low and comparatively level, with a very irregular outline due to the many bays and rivers that open into Chesapeake Bay. Next to the west is the Piedmont region, more elevated and broken into hills and valleys. The narrow western part, in the Appalachian Plateau, is crossed by numerous mountain ridges, and has an average elevation of 2,500 feet.

**Soils.** The soils of the eastern half are sandy loams well suited to the cultivation of fruits and vegetables. West of these are limestone and shale formations with an admixture of clay, most of them being very fertile, especially in the valleys. The mountainous western part is adapted to live stock and diversified farming typical of the northern states. The soils are strong and productive. Grass, clover, corn and alfalfa abound.

**Climate.** This varies greatly between the low coast region and the elevated western part. In the former, extending to the District of Columbia, the climate is comparatively even, the average annual temperature being 54 degrees. The highest recorded is 105 degrees at Annapolis, and the lowest, 15 below zero at Easton. The frost-free season averages about 185 days, and the average annual rainfall is about 44 inches, varying about 10 inches at different stations. Snowfalls are light and do not last long. The remainder

of the State has an annual average temperature of 53 degrees; the highest recorded temperature is 107 degrees at Westernport, and the lowest, 23 degrees below zero at Bachman's Valley. Even when hot spells occur here, the nights are usually cool. Average annual rainfall is 39 inches, pretty well distributed throughout the year. Average frost-free season is about 170 days.

**Opportunities.** Maryland offers unusual agricultural opportunities by virtue of its variety of soil, mild and salubrious climate, nearness to markets and the wide range in the phases of the industry that can be conducted successfully. Considering its possibilities, good land is reasonable in price. Information about land may be obtained from the State Board of Agriculture, College Park.

**Products and industries.** Leading farm activities are general farming and fruit and vegetable growing. Corn is the leading cereal, followed by wheat, oats and rye. Hay and forage, potatoes, and sweet potatoes and tobacco are produced. Apples lead the orchard fruits, being largely grown in the western part, the rest being mostly pears, peaches and nectarines. Grapes are grown to a considerable extent. Vegetable growing is extensive, both for market and for canning. Nearly half the pack of tomatoes in the country is in Maryland. Strawberries are the leading small fruit, followed by raspberries, blackberries and dewberries. Horses and cattle are the most important farm animals. Hogs, sheep and poultry are rapidly increasing. About 3,000 square miles of forests permit considerable lumbering, mostly hardwoods. Maryland is among the leaders in fisheries, oysters and crabs being important sea crops. Its diamond-back terrapin and canvas-back duck are world famed. Coal is the most valuable mineral, but iron, granite, roofing slate, feldspar and clay are important. Main manufactures in order of importance are clothing, copper, tin and sheet-iron; canned products including fruits, vegetables, fish, oysters, pickles and preserves, meats; lumber and timber, tobacco, fertilizers and flour. Baltimore is the leading manufacturing city.

**Transportation and markets.** Maryland is well served by railroads in all parts. There are numerous electric lines. Chesapeake Bay with its numerous branches furnishes ample communication both internally and for export trade. There are also numerous connecting canals that help the inland communication. The Potomac River is also an important means of water communication in the south and west. Baltimore is a port of entry with extensive exports and imports. Maryland is famous for her excellent state-controlled road system. Excellent roads connect all important points. The network is being rapidly increased. In 1917 there were, approximately, 1,000 miles of state roads and 300 miles of state-aided roads. These roads are constructed of macadam, concrete, gravel and shell.

**History.** Maryland was granted by Charles I to the Second Lord Baltimore in 1632. The first colonists arrived in 1634, and laid out the City of St. Mary's. Here the first assembly met, 1635. The capital was removed to Annapolis in 1694. Baltimore was founded in 1730. Maryland was a leader in the Revolutionary War, and was one of the original 13 colonies. In the Civil War, Maryland's sympathies were divided, but she remained in the Union.

**Agricultural organization.** State Board of Agriculture, *Baltimore* and *College Park*, is in charge of all State work in agriculture. Maryland State College of Agriculture, *College Park*. The Experiment Station and Extension Service are Divisions of the State College. The executive officer of the State Board of Agriculture is the President of the State College. The State College, in coöperation with the U. S. Department of Agriculture, maintains Agricultural Agents and Home Economics Agents in every county of the State. The Maryland Agricultural Society is a federation of the Maryland Horticultural Society, Maryland Crop Improvement Association, Maryland Dairymen's Association and the Maryland Beekeepers' Association. The address of the Secretary of the Agricultural Society is *College Park*. These organizations hold annually an agricultural and horticultural exhibition in Baltimore known as the Maryland Week Exposition. There are held annually a number of local or county fairs, among which the Hagerstown Fair and the Frederick Fair are the most important. There is no State Fair. The Maryland State Grange is a branch of the National Organization, and is well organized in most of the counties of the state.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | |
|---|---|
| Population | 1,449,661; *1,295,346* |
| City | 869,422 (60%); *658,192 (50.8%)* |
| Country | 580,239 (40%); *637,154 (49.2%)* |
| Number of farmers | 47,908; *48,923* |
| White | 41,699 (87%); *42,581 (87%)* |
| Non-white | 6,209 (13.%); *6,372 (13.%)* |
| Land area, acres | 6,362,240 |
| Acres in farms | 4,757,999; *5,057,140* |
| Acres farm land improved | 3,136,728; *3,354,767* |
| Av. acres per farm | 99.3 (65.4 impr.); *103.4* (*68.6* impr.) |
| Acres artificially drained | 249,799 (8% impr. farm land) |
| Acres needing drainage | 184,820 (3.9% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 9,473; *10,232* |
| 20 " 49 " | 9,003; *8,629* |
| 50 " 99 " | 10,452; *9,946* |
| 100 " 174 " | 11,178; *11,457* |
| 175 " 499 " | 7,344; *8,070* |
| Over 500 " | 458; *589* |
| Value all farm property | $463,638,120; *$286,167,028* |
| Per cent increase in ten years | 61; *39.8* |
| Value farm land | $259,904,047; *$163,451,614* |
| " " buildings | $126,692,803; *$78,285,509* |
| " " implements | $28,970,020; *$11,859,771* |
| " " livestock | $48,071,250; *$32,570,134* |
| Av. value all property per farm | $9,678; *$5,849* |
| " " land and buildings per acre | $81.25; *$47.80* |

Farms run by owners...32,805 (68.4%); *33,519 (68.5%)*
Farms run by tenants...13,841 (28.9%); *14,416 (29.5)%*
Per cent owned farms unmortgaged..........58.8; *62.9*
Per cent farms reporting automobiles 33.5; telephones 24.5

**2. Crop Acreages, Yields, Values, 1919 and *1909***

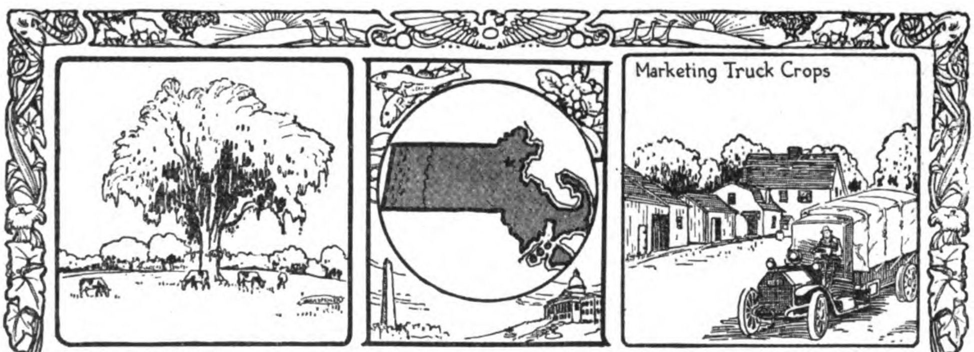
| | | |
|---|---|---|
| Value all farm crops | $109,858,608; | *$40,330,688* |
| " " cereals | $55,845,785; | *$21,908,730* |
| Corn, acres | 619,265; | *647,012* |
| production (bu.) | 21,083,076; | *17,911,436* |
| 10-yr. av. yield per acre | | 37 bu. |
| Wheat, acres | 664,295; | *589,893* |
| production (bu.) | 9,620,526; | *9,463,457* |
| 10-yr. av. yield per acre | | 16 bu. |
| Oats, acres | 48,891; | *49,210* |
| production (bu.) | 1,082,994; | *1,160,663* |
| 10-yr. av. yield per acre | | 30 bu. |
| Rye, acres | 21,196; | *28,093* |
| production (bu.) | 230,596; | *357,562* |
| 10-yr. av. yield per acre | | 15.4 bu. |
| Hay and forage, acres | 622,939; | *398,842* |
| production (tons) | 806,910; | *477,564* |
| value | $16,245,825; | *$6,012,865* |
| Potatoes, white, acres | 46,837; | *39,299* |
| production (bu.) | 4,918,766; | *3,444,311* |
| 10-yr. av. yield per acre | | 89 bu. |
| sweet, acres | 10,185; | *7,956* |
| production (bu.) | 1,453,880; | *1,065,956* |
| 10-yr. av. yield per acre | | 128 bu. |
| Buckwheat, acres | 8,736; | *10,388* |
| production (bu.) | 168,639; | *152,216* |
| Tobacco, acres | 28,550; | *26,072* |
| production (lbs.) | 17,336,859; | *17,845,699* |
| Maple sugar, trees tapped | 74,549; | *79,658* |
| sugar made (lbs.) | 150,957; | *351,908* |
| syrup made (gals.) | 23,155; | *12,172* |
| Strawberries, acres | 7,096; | *14,292* |
| Strawberries, production (quarts) | 8,976,057; | *26,611,095* |
| Vegetables, acres 119,922; value | $25,419,167; | *$7,996,105* |
| Apples, production (bu.) | 1,518,884; | *1,882,824* |
| Pears, production (bu.) | 287,199; | *367,359* |
| Peaches, production (bu.) | 564,111; | *324,609* |
| Plums and prunes, (bu.) | 18,540; | *13,526* |
| Grapes; production (lbs.) | 1,540,958; | *2,152,382* |
| Forest products, value | $4,673,536; | *$2,349,045* |

Nurseries: no. 53; acres 3,015; receipts ........$392,464
Greenhouses: sq. ft. of glass, 2,162,958; receipts, $931,999

**3. Livestock, 1920 and *1910***

Farms reporting livestock....45,674; pure breds 3,179

| | | |
|---|---|---|
| Value all livestock on farms | $48,071,250; | *$32,570,134* |
| Horses, number | 141,341; | *155,438* |
| value | $13,835,411; | *$16,787,467* |
| Mules, number | 32,621; | *22,667* |
| value | $4,138,764; | *$3,043,581* |
| All cattle, number | 283,377; | *287,751* |
| value | $20,363,801; | *$7,869,526* |
| Beef cattle, number | 53,666; | |
| Dairy cattle, number | 229,711; | *166,859* |
| Sheep, number | 103,027; | *237,137* |
| value | $1,262,798; | *$1,142,965* |
| Swine, number | 306,452; | *301,583* |
| value | $4,169,974; | *$1,765,857* |
| Poultry, number | 3,688,566; | *2,908,958* |
| value | $4,216,105; | *$1,858,570* |
| Bees, number of hives | 16,117; | *23,156* |
| Livestock products, value | $25,522,172; | *$11,967,668* |
| Value all dairy products | $13,407,526; | *$5,480,900* |
| " eggs and chickens | $11,737,629; | *$6,247,141* |
| " wool and mohair | $320,180; | *$200,383* |
| " honey and wax | $56,837; | *$39,244* |
| Milk produced (gallons) | 58,754,193; | *41,094,421* |
| Butter made (lbs.) | 894,883; | *1,563,161* |
| Eggs produced (dozens) | 15,085,691: | *15,238,591* |




# MASSACHUSETTS

MASSACHUSETTS ("Bay State"), one of the New England States, lies between 41 and 43 degrees north latitude, and 70 and 74 degrees west longitude. The largest river is the Connecticut which flows entirely across the state from north to south. West of this the Hoosac River flows to the Hudson and the Housatonic to Long Island Sound. The Merrimac flows through the northeast corner into the Atlantic. Area, 8,266 square miles of which 227 are water. Perhaps half the state is forested, chiefly by second-growth timber.

Land surface. An elevated ridge crosses the state from north to south about in the center. East of this, the slope is toward the east and southeast; the southeastern part, including a few islands, is low and sandy, often marshy. A plateau with about 1,000 feet elevation, sloping westward toward the Connecticut River, lies west of the central divide. West of the river the surface is hilly and broken, making up the Berkshire Hills and the Hoosac and Taconic Mountains. The highest points are Greylock, 3,535 feet, Mt. William, 3,040 feet, Mt. Everett, 2,625 feet.

Soils. The soils all over the state are typical glacial formations, well sprinkled with rocks and boulders. Along the coast they become lighter, and vary from marshy to almost clear sand; in the river valleys, they are

naturally deeper and richer. For the most part they are naturally strong, fertile unless worn out by poor methods, and in any case responsive to care and special treatment. Lime is quite generally deficient, its use being quite essential to satisfactory results with most crops. The supply of manures is not sufficient to maintain production at a satisfactory level, and commercial fertilizers are largely employed. The Connecticut River Valley is especially rich and productive. The rocky nature of the soils, and the small, irregular-shaped fields have generally made extensive farming difficult. Capital, however, has in recent years been more extensively employed, obstacles to the use of machinery (such as boulders, stones and old fences) have been removed, and extensive farm operations are becoming increasingly common.

**Climate.** The Massachusetts winter is long and cold with a good deal of snow. However, in the western, higher section where the lowest temperatures occur, the drier air makes the winter seem less severe than in the lower, moister eastern country. The ocean modifies the summer temperatures along the coast and also causes frequent fogs; inland a generally cool summer with occasional short spells of really hot weather may be expected. The frequent changes of weather result in a varied climate that is either thoroughly enjoyed or thoroughly disliked, though spring and fall are usually very pleasant. The average annual temperature is 47.5 degrees; highest recorded 102 degrees at Boston and Lawrence; lowest, 28 degrees below zero at Turners Falls. Average annual snowfall varies from 26.1 inches at Nantucket (on the coast) to 61.5 inches at Fitchburg (in the hills). Average annual precipitation (rain and snow), 45 inches. Frost-free season averages 165 days.

**Opportunities.** There are some untilled farms, and considerable unimproved land in some parts of the state. Information may be obtained from the State Board of Agriculture at Boston.

**Products and industries.** Massachusetts is primarily a manufacturing state; its agriculture is varied but includes, chiefly, general farming on rather small areas and intensive dairying and fruit, vegetable and poultry raising designed to supply local markets—the larger cities and the smaller but thickly populated factory towns. Grains are not largely grown, but hay is a very important crop both for home feeding and for marketing; both climate and soil are well suited to grass growing. Orchards are scattered over the state and a good many apples are produced; small fruits are a more important product. Vegetable growing is highly developed around the cities and a large acreage of greenhouses and hotbeds aids in forcing early crops of both vegetables and flowers, and the production of hothouse fruits, vegetables and flowers. Tobacco and onions of highest quality are the main crops in the Connecticut Valley, while the bogs of Cape Cod form one of the few commercial centers of the cranberry industry. Lumbering is not an important business though most farmers maintain and derive profit from their woodlots. Dairying in the center and northern sections of the state and poultry raising in the south and southeast are the leading livestock activities; there are many good herds of purebred dairy cattle. Except for its hay, hothouse vegetables and flowers, cranberries, tobacco and onions, Massachusetts aims to meet its own needs rather than those of other sections. Ocean fisheries are a source of great wealth, Massachusetts being a leader in this industry since Colonial days. Leading minerals are granite, sandstone, marble, clay, emery, graphite and asbestos. Its extensive river water power is at the basis of the importance of Massachusetts in manufacturing. Main products are boots and shoes, rubber goods, machinery and allied products, cotton and woolen goods, leather, jewelry, cordage and twine, paper and wood pulp, hosiery and knit goods, carpets and rugs, confectionery, furniture, electrical apparatus, refined sugar and molasses. Leading manufacturing cities are Fall River, Lowell, New Bedford, Lawrence and Taunton of cotton goods; Brockton, Lynn and Haverhill boots and shoes; Holyoke, paper and wood pulp; Springfield, firearms, machinery; Lawrence, worsted goods; Worcester, machinery, iron and steel, carpets; Attleboro and North Attleboro jewelry; Pittsfield, electrical machinery.

**Transportation and markets.** Massachusetts was the pioneer in railroad construction and is well covered with both steam and electric lines. The percentage of improved roads —which are well kept up—in relation to total mileage is higher than in any other state. There are 10 ports of entry, and communication by water is carried on to many parts of the country and of the world.

**History.** First settlement by the Pilgrims at Plymouth, in 1620. Boston was settled in 1630. Massachusetts was declared a royal province in 1684. In 1774 a state government and militia were organized, and in 1780, the present constitution was adopted and slavery was abolished. In 1788, the United States Constitution was ratified.

**Agricultural organization.** Agricultural College and Experiment Station, *Amherst;* Asparagus Branch Station, *Concord;* Cranberry Branch Station, *Wareham;* State Board of Agriculture, *Boston.* There are also Creamerymen's Association, Fruit Growers' Association, Horticultural Society, Forestry Association, Dairymen's Association, Poultry Association, Cattle Owners' Association, Nurserymen's Association.

The Experiment Station Director reports that, in recent years there has been a small

decrease in the state's total area under cultivation, but an increase in the total of agricultural products, and a large increase in their value. The tendency has been to give up carelessly and half-cultivated areas and those poorly suited for farm operations, and to do more thorough work on better located and naturally better soils. A further tendency for many years has been toward special crops. As a consequence, capital has been attracted, considerable areas have been reclaimed, and large commercial farm ventures are increasingly common. These developments have been carried on chiefly through private capital and enterprise. But the state has done something in the better utilization of its land areas through the employment of dependent and unemployed classes in reclamation projects. The State Forester is also empowered, under certain conditions, to purchase unimproved land and reforest it, the plan being to allow the original owners to repurchase if they so desire. The most significant crop change of recent years is in the discovery and perfection of methods under which alfalfa may be successfully cultivated. Recent years have seen successful efforts aimed towards community betterment and coöperative organization. The large proportion of highly improved state, county and town roads has contributed largely to these improvements.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | | |
|---|---|---|
| Population | 3,852,356; | *3,366,416* |
| City | 3,650,248 (94.8%); | *3,125,367 (92.8%)* |
| Country | 202,108 (5.2%); | *241,049 (7.2%)* |
| Number of farmers | 32,001; | *36,917* |
| White | 31,880 (99.6%); | *36,793 (99.7%)* |
| Non-white | 121 (.4%); | *124 (.3%)* |
| Land area, acres | 5,144,960 | |
| Acres in farms | 2,494,477; | *2,875,941* |
| Acres farm land improved | 908,834; | *1,164,501* |
| Average acres per farm | 77.9 (28 impr.); | *77.9 (31.5 impr.)* |
| Farm land artificially drained | 39,022 (4.3% impr. farm land) | |
| Farm land needing drainage | 80,883 (3.2% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 9,505; | *10,606* |
| 20 " 49 " | 7,532; | *8,890* |
| 50 " 99 " | 6,834; | *7,981* |
| 100 " 174 " | 4,888; | *5,703* |
| 175 " 499 " | 2,895; | *3,325* |
| Over 500 " | 347; | *412* |
| Value all farm property | $300,471,743; | *$226,474,025* |
| Per cent increase in ten years | 326; | *24* |
| Value farm land | $127,563,607; | *$105,532,616* |
| " " buildings | $119,934,224; | *$88,636,149* |
| " " implements | $19,359,755; | *$11,563,894* |
| " " livestock | $33,524,157; | *$20,741,366* |
| Av. value all property per farm | $9,389; | *$6,135* |
| " " land and buildings per acre | $99.25; | *$67.51* |
| Number farms run by owners | 28,087 (87.5%); | *32,075 (86.9%)* |
| Number farms run by tenants | 2,287 (7.1%); | *2,979 (8.1%)* |
| Per cent owned farms unmortgaged | 50; | *58.5* |
| Per cent farms reporting automobiles 25.6; telephones 51.7 | | |

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value all farm crops | $53,700,925; | *$26,191,705* |
| " " cereals | $3,411,343; | *$1,617,131* |
| Corn, acres | 28,953; | *41,755* |
| production (bu.) | 1,515,933; | *2,029,381* |
| 10-yr. av. yield per acre | 46 bu. | |
| Wheat, acres | 1,876; | *109* |
| production (bu.) | 33,253; | *2,404* |
| Oats, acres | 9,533; | *7,927* |
| production (bu.) | 287,881; | *268,500* |
| 10-yr. av. yield per acre | 35.8 bu. | |
| Rye, acres | 3,062; | *3,476* |
| production (bu.) | 46,261; | *59,183* |
| 10-yr. av. yield per acre | 18.4 bu. | |
| Buckwheat, acres | 1,304; | *1,630* |
| production (bu.) | 23,238; | *32,926* |
| 10-yr. av. yield per acre | 18.2 bu. | |
| Hay and forage, acres | 466,330; | *519,503* |
| production (tons) | 871,573; | *831,955* |
| value | $20,149,137; | *$11,290,758* |
| Potatoes, white, acres | 21,558; | *24,459* |
| production (bu.) | 1,885,655; | *2,946,178* |
| 10-yr. av. yield per acre | 116 bu. | |
| Tobacco, acres | 9,109; | *5,521* |
| production (lbs.) | 14,282,589; | *9,549,306* |
| 10-yr. av. yield per acre | 1,540 lbs. | |
| Maple sugar, trees tapped | 252,751; | *256,501* |
| sugar made (lbs.) | 73,198; | *156,952* |
| syrup made (gals.) | 57,950; | *53,091* |
| Small fruits, acres | 9,628; | *9,552* |
| production (quarts) | 27,099,119; | *29,260,143* |
| Strawberries, acres | 1,432; | *2,015* |
| production (quarts) | 3,151,371; | *5,518,867* |
| Vegetables, acres 24,747; value | $15,348,069; | *$8,184,213* |
| Apples, production (bu.) | 3,187,211; | *2,550,259* |
| Pears, production (bu.) | 84,486; | *96,071* |
| Peaches, production (bu.) | 213,139; | *91,756* |
| Plums and prunes, (bu.) | 13,152; | *17,814* |
| Grapes, production (lbs.) | 1,009,479; | *1,132,838* |
| Forest products, value | $4,491,522; | *$2,668,410* |
| Nurseries: acres 1,517 in 107 establishments; receipts | $743,323 | |
| Greenhouses: sq. ft. under glass 12,953,023; receipts | $5,536,532 | |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Number farms reporting livestock | 27,508; | pure breds 3,546 |
| Value all livestock on farms | $33,524,157; | *$20,741,366* |
| Horses, number | 50,605; | *64,283* |
| value | $7,771,029; | *$8,671,997* |
| Mules, number | 332; | *268* |
| value | $44,251; | *$43,385* |
| All cattle, number | 216,099; | *252,416* |
| value | $20,093,098; | *$9,348,076* |
| Beef cattle, number | 10,089; | |
| Dairy cattle, number | 206,010; | *171,936* |
| Sheep, number | 18,880; | *32,708* |
| value | $237,023; | *$156,498* |
| Goats, number | 1,296; | *1,251* |
| value | $23,506; | *$7,990* |
| Swine, number | 104,192; | *103,018* |
| value | $2,339,114; | *$978,989* |
| Poultry, number | 1,517,477; | *1,798,380* |
| value | $2,951,001; | *$1,492,961* |
| Bees, number of hives | 6,573; | *7,464* |
| Livestock products, value | $33,850,892; | *$21,932,652* |
| Value all dairy products | $24,765,522; | *$15,187,774* |
| " eggs and chickens | $9,004,007; | *$6,691,523* |
| " wool and mohair | $56,003; | *$34,179* |
| " honey and wax | $25,360; | *$19,176* |
| Milk produced (gallons) | 76,316,309; | *86,304,347* |
| Butter made (lbs.) | 2,019,231; | *3,364,576* |
| Eggs produced (dozens) | 9,604,274; | *13,961,352* |

# MICHIGAN

**MICHIGAN** ("Wolverine" or "Badger State"), one of the North Central States, lies between 41 and 48 degrees north latitude, and 82 and 91 degrees west longitude. It is divided by Lakes Michigan and Huron into the Upper and Lower Peninsulas. Except for the southern boundary of the Lower Peninsula and a small part of the southwestern boundary of the Upper Peninsula, Michigan is entirely bounded by water. The Lower Peninsula is separated from Canada by Lake Huron and the St. Clair and Detroit Rivers. The Upper Peninsula is separated from Wisconsin by the Montreal and Menominee Rivers, and from Canada by the St. Mary's River. Area (including some 200 islands), 57,980 square miles, 500 of which are water.

Land surface. Most of the Southern Peninsula is comparatively level, the highest point being only about 700 feet above the lake level. The highest point in relation to the whole country is Otsego Lake, 1,280 feet above sea level, which is on the divide extending northeast and southwest and separating the area that drains into Lake Michigan on the west from that which drains into Lakes Huron and Erie on the east. There are several large lakes, and an immense number (estimated at from 5,000 to 15,000) of small lakes and ponds. Numerous bays indent the coast, the largest being Saginaw and Thunder Bay on the east, and Grand Traverse and Little Traverse Bays on the northwest. The Northern Peninsula is higher, the Porcupine Mountains, close to, and parallel with, the northwest coast, reaching above 2,000 feet.

Soils. Those of the Lower Peninsula are largely glacial drift of a sandy loam type. The river valleys and beds of dried-up lakes are rich alluvial soil. Some of the pine lands in the north are unproductive. In the southeast are heavy clays. In the south central and southwest, are great areas of muck lands suitable for onions, celery and similar special crops. The eastern end of the Upper Peninsula has much black soil which is very fertile when drained. West of this is a rolling surface and a lighter soil well adapted to agriculture. Next is a rough and rocky region little suited for farming, but farther west is another good-sized area of fertile soil.

Climate. This is affected by the higher elevations in the north, the large bodies of water, and the storms that move eastward across the Lake Region, the latter causing frequent and sudden changes. In the north, the average annual temperature ranges from 38 to 43 degrees according to elevation. Lowest and highest recorded temperatures are 49 degrees below zero and 108 degrees above. An annual snowfall of 121.4 inches has been recorded. The average annual rainfall is 35 inches, and the frost-free season, about 120 to 130 days. In Lower Michigan the climate of the western part is much modified by the nearby lake which tempers both the cold of winter and the heat of summer. The average annual rainfall varies from about 30 inches in the north to 40 inches in the south, and snowfall from 90 inches to 40 inches. Highest and lowest recorded temperatures are 104 degrees above and 43 degrees below zero. Average annual temperature is about 46 degrees. The frost-free season averages about 150 days. Tornadoes are sometimes very destructive.

Opportunities. Michigan is said to be the nearest to self-sustaining of any state, about all the necessities of life except cotton being produced within its borders. Its natural resources are extremely varied. Large areas of Michigan land are as yet undeveloped. Particulars about this land may be obtained from the State Geologist at Lansing.

Products and industries. Leading agricultural activities are general farming, based on cereal production; the raising of apples in the south and west; of peaches along the western lake front; of grapes, especially along Lake Erie and on the western lake front; of celery, onions and peppermint on the black muck soils; of lettuce and cucumbers under glass in the vicinity of Grand Rapids; and of most other

vegetables in all parts of the state. Michigan produces about 50 per cent of the world's supply of peppermint oil. Special lines of considerable importance are vegetable and flower-seed growing and the raising of peas and other vegetables for canning. Large areas are devoted to sugar beets. Cattle and sheep are the most important livestock, and both dairying and poultry raising are extensively practised. Lumbering is not so extensive as formerly, since large areas have now been cut over. The lake fisheries are extensive. Leading minerals are iron and copper in the northern peninsula, coal and salt. Main manufactures are of automobiles, lumber and timber, foundry, and machine-shop products, flour and cereal foods, refined copper, carriages and wagons, furniture, railroad cars, leather, agricultural implements, dairy products, paper and wood pulp, iron and steel. Grand Rapids is the greatest furniture manufacturing center in the world, and Detroit leads in automobiles.

**Transportation and markets.** No state has better transportation facilities. Railroads cover the state, connecting with the east, west and south. There is a large mileage of electric railways. The Great Lakes transport immense quantities of freight, Michigan having about 50 recognized harbors. A canal across the Northern Peninsula connects Lakes Michigan and Superior, and through the Chicago River and Canal, there is an outlet to the Mississippi and the Gulf. Chicago, Illinois, is the great market for the state, but the many manufacturing and mining centers furnish excellent markets within it.

**History.** First explorers were French missionaries and fur traders about 1610. In 1667, Father Marquette founded a mission at Sault Ste. Marie. Settlements were made at Mackinac, 1671, and Detroit, 1701. The region passed into the hands of the English, 1763. Territory incorporated in Canada in 1774. Ceded to United States in 1783. State Constitution adopted 1835. Admitted to statehood 1837. Capital at Detroit until 1847, then Lansing (population, 1910, 20,276).

**Agricultural organization.** Agricultural College and Experiment Station, Coöperative Demonstration Work, *East Lansing*. There are also a State Agricultural Society, Horticultural Society, Experiment Association, Potato Growers' Association; Livestock Breeders and Feeders' Association, Veterinary Board, Grange, Gleaners, and numerous Farmers' Clubs.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 3,668,412; | *2,810,173* |
| City | 2,241,560 (61.1%); | *1,327,044 (47.2%)* |
| Country | 1,426,852 (38.9%); | *1,483,129 (52.8%)* |
| Number of farmers | 196,447; | *206,960* |
| White | 195,714 (99.6%); | *206,014 (99.5%)* |
| Non-white | 733 (.4%); | *946 (.5%)* |
| Land area, acres | 36,787,200 | |
| Acres in farms | 19,032,961; | *18,940,614* |
| Acres farm land improved | 12,925,521; | *12,832,078* |
| Average acres per farm | 97.3 (70 impr.); | *91.5* (*62* impr.) |
| Acres artificially drained | 3,156,632 (24.4% impr. farm land) | |
| Acres needing drainage | 2,070,387 (10.9 all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 12,744; | *14,785* |
| 20 " 49 " | 40,765; | *49,890* |
| 50 " 99 " | 71,391; | *73,748* |
| 100 " 174 " | 52,645; | *50,622* |
| 175 " 499 " | 18,075; | *17,143* |
| Over 500 " | 827; | *772* |
| Value all farm property | $1,763,334,778; | *$1,088,858,376* |
| Per cent increase in ten years | 62.; | *57.7* |
| Value farm land | $959,186,538; | *$615,258,348* |
| " " buildings | $477,499,672; | *$285,879,951* |
| " " implements | $122,389,936; | *$49,916,285* |
| " " livestock | $204,258,632; | *$137,803,795* |
| Av. value all property per farm | $8,976; | *$5,261* |
| " " land and buildings per acre | $75.48; | *$47.58* |
| Farms run by owners | 159,406 (82.1%); | *172,310 (83.2%)* |
| Farms run by tenants | 34,722 (17.7%); | *32,689 (15.8%)* |
| Per cent owned farms unmortgaged | 49.4; | *48.* |
| Per cent farms reporting automobiles 40.2; telephones 49.8 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $404,014,810; | *$152,102,869* |
| " " cereals | $170,897,885; | *$70,544,250* |
| Corn, acres | 1,269,155; | *1,589,596* |
| production (bu.) | 45,088,912; | *52,906,842* |
| 10-yr. av. yield per acre | 32.8 bu. | |
| Wheat, acres | 1,056,687; | *802,137* |
| production (bu.) | 20,411,825; | *16,025,791* |
| 10-yr. av. yield per acre | 16.8 bu. | |
| Oats, acres | 1,514,808; | *1,429,076* |
| production (bu.) | 36,956,425; | *43,869,502* |
| 10-yr. av. yield per acre | 34 bu. | |
| Rye, acres | 912,951; | *419,020* |
| production (bu.) | 12,168,182; | *5,814,394* |
| 10-yr. av. yield per acre | 14.6 bu. | |
| Barley, acres | 296,515; | *93,065* |
| production (bu.) | 4,802,768; | *2,132,101* |
| 10-yr. av. yield per acre | 25.4 bu. | |
| Hay and forage, acres | 3,644,952; | *2,715,301* |
| production (tons) | 6,345,510; | *3,632,939* |
| value | $105,280,992; | *$36,049,801* |
| Potatoes, white, acres | 280,538; | *365,483* |
| production (bu.) | 23,929,560; | *38,243,828* |
| 10-yr. av. yield per acre | 90 bu. | |
| Buckwheat, acres | 41,426; | *75,909* |
| production (bu.) | 524,004; | *958,119* |
| 10-yr. av. yield per acre | 14.1 bu. | |
| Maple sugar, trees tapped | 858,881; | *986,737* |
| sugar made (lbs.) | 77,178; | *293,301* |
| syrup made (gals.) | 206,795; | *269,093* |
| Small fruits, acres | 20,021; | *21,419* |
| production (quarts) | 23,946,801; | *27,214,659* |
| Strawberries, acres | 8,048; | *8,051* |
| production (quarts) | 12,585,543; | *14,218,768* |
| Vegetables, acres 50,955; value | $65,096,550; | *$16,201,328* |
| Apples, production (bu.) | 5,843,271; | *12,332,296* |
| Pears, production (bu.) | 405,189; | *666,023* |
| Peaches, production (bu.) | 448,177; | *1,686,586* |
| Plums and prunes, (bu.) | 203,091; | *181,188* |
| Grapes, production (lbs.) | 115,871,465; | *120,695,997* |
| Forest products, value | $12,649,621; | *$7,911,901* |
| Nurseries: no. 170; acres 1,591; receipts | $779,155 | |
| Greenhouses: sq. ft. of glass 5,672,838; receipts $2,766,760 | | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Farms reporting livestock | 186,354; | pure breds 21,873 |
| Value all livestock on farms | $204,258,632; | *$137,803,795* |
| Horses, number | 605,509; | *610,033* |
| value | $56,433,765; | *$71,312,474* |
| Mules, number | 5,884; | *3,700* |
| value | $661,115; | *$493,825* |
| All cattle, number | 1,586,042; | *1,497,823* |
| value | $101,717,971; | *$40,500,318* |
| Beef cattle, number | 329,901; | |
| Dairy cattle, number | 1,256,141; | *767,083* |
| Sheep, number | 1,209,191; | *2,306,476* |
| value | $13,688,379; | *$9,646,565* |
| Goats, number | 1,607; | *5,080* |

| | | | | | |
|---|---|---|---|---|---|
| Goats, value | $11,037; | | Value all dairy products | $71,074,727; | *$26,727,538* |
| Swine, number | 1,106,066; | *1,245,833* | " eggs and chickens | $34,960,771; | *$17,926,239* |
| value | $19,621,714; | *$9,755,042* | " wool and mohair | $4,623,778; | *$3,430,032* |
| Poultry, number | 11,183,064; | *9,967,039* | " honey and wax | $416,959; | *$296,742* |
| value | $11,587,814; | *$5,610,958* | Milk produced (gallons) | 382,822,631; | *283,387,201* |
| Bees, number of hives | 93,348; | *115,274* | Butter made (lbs.) | 8,666,037; | *27,200,509* |
| Livestock products, value | $111,076,235; | *$48,380,551* | Eggs produced (dozens) | 55,986,999; | *59,556,356* |

# MINNESOTA

MINNESOTA ("Gopher" or "North Star State"), one of the North Central States, lies between 43 and 49 degrees north latitude, and 91 and 98 degrees west longitude. Natural boundaries are the Mississippi and St. Croix Rivers and Lake Superior on the east, and several smaller lakes and rivers on the north and west. The largest rivers within the state are the Minnesota, flowing across it into the Mississippi at St. Paul and Minneapolis; the Red Lake and the Wild, flowing into the Red River of the North, and the St. Louis in the northeast discharging into Lake Superior. Area, 84,682 square miles, 3,824 of which are water.

**Land surface.** The general elevation above sea level ranges from about 640 feet in the southeast and 607 feet at Duluth on Lake Superior, to 1,300 and 2,000 feet in the north central part, and 2,400 feet in the northeastern part. In the northwest part, are level prairies; most of the rest of the state is gently rolling, except for the broken surface along the Mississippi where the bluffs sometimes reach 400 feet in height. Many small lakes (10,000 named) are scattered over the state, mostly in the northern part, where there are extensive areas with poor natural drainage.

**Soils.** These are mostly a glacial drift, very fertile except in the northern part, where both sandy and rocky land is unfitted for agriculture. Clayey loams are found on the elevations, and very fertile alluvial soils in the river valleys, particularly that of the Red River of the North. Hundreds of miles of drainage ditches in this region render available an area equal in size to the state of Rhode Island, containing some very fine agricultural lands.

**Climate.** In general this is rigorous in winter, mild in summer, healthful at all seasons. Temperatures vary much in different parts. The average annual temperature is 39 degrees at Duluth; 35 degrees at St. Vincent in the extreme northwest corner; 46 degrees in the southeastern part. Highest recorded temperature is 110 degrees at New London; lowest, 59 degrees below zero at St. Vincent. The frost-free season averages about 120 days in the north, 135 days in the southwest, and 145 days in the southeast. In the north the average annual rainfall decreases from 32 inches in the east to 23 inches in the west, 75 per cent of which falls from April to September. In the south the average rainfall is about 30 inches, the larger part again coming during the growing season. The average snowfall varies from 24 inches at New London, in the south central part, to 54.4 inches at Mt. Iron, in the northeast.

**Opportunities.** Information about agricultural opportunities may be obtained from the Agricultural Experiment Station, University Farm, St. Paul.

**Products and industries.** Leading farm activities are the production of spring wheat, oats and corn in the southern part; flaxseed, spring wheat and potatoes in the northern part. Cattle and swine are the leading livestock, and dairying is extensive and steadily increasing. Trucking near the cities is important. Lumbering has been important, but the forests have been considerably depleted. Lake and river fisheries are important. The leading mineral is iron ore, found in the form of the richest deposits in the world. Main manufactures are flour, in which Minnesota far outranks any other state; lumber and timber products; meat products; cheese, butter and condensed milk; railroad cars; linseed oil Minneapolis is the center of the milling in.

**dustry, and with St. Paul is the chief manufacturing center.**

**Transportation and markets.** Except in the north, the state is well covered by railroads, Minneapolis and St. Paul being great railroad centers. Much transportation is effected by way of the Great Lakes and the Mississippi River. Duluth, a port of entry, is one of the most important of the Lake ports. A larger tonnage leaves the Duluth-Superior harbor annually than leaves New York harbor. St. Paul is also a port of entry, and both are important markets.

**History.** In 1678, a fort was established on the north shore of Lake Superior, by Duluth, a Frenchman. In 1680, Hennepin, a French missionary, discovered the Falls of St. Anthony, and by 1700 the French had founded trading posts on Lake Pepin and the Minnesota River. The territory was ceded to the English in 1763, and to the United States in 1783. The portion west of the Mississippi was included in the Louisiana Purchase, acquired from France in 1803. Minnesota was admitted to statehood in 1858. The liberal homestead laws resulted in a rapid increase of population. There is a large foreign population, especially in the country. The number of foreign-born farmers exceeds those native-born. Capital, St. Paul; population, 1910, 214,744. Minneapolis is the largest city; population, 1910, 301,408.

**Agricultural organization.** College of Agriculture and Experiment Station, *University Farm, St. Paul.* Sub-experiment stations are located at *Crookston, Morris, Grand Rapids, Duluth* and *Waseca.* Coöperative Demonstration Work, *St. Paul*; Horticultural Society, *Minneapolis*; Field Crop Breeders' Association, Beekeepers' Association, Live Stock Breeders' Association, all *University Farm, St. Paul.* There are the Agricultural Society, Swine Breeders' Association, Dairymen's Association, Guernsey Breeders' Association, Sheep Breeders' Association, Horse Breeders' Association, Hereford Breeders' Association, and Stallion Registration Board.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| **Population** | 2,387,125; | *2,075,708* |
| City | 1,051,593 (44.1%); | *850,294 (41%)* |
| Country | 1,335,532 (55.9%); | *1,225,414 (59%)* |
| **Numbers of farmers** | 178,478; | *156,137* |
| White | 178,271 (99.9%); | *155,844 (99.8%)* |
| Non-white | 207 (.1%); | *293 (.2%)* |
| **Land area, acres** | 51,749,120 | |
| **Acres in farms** | 30,221,758; | *27,675,823* |
| **Acres farm land improved** | 21,481,710; | *19,643,533* |
| **Av. acres per farm** | 113.2 (120 impr.); | *177 (125.8 impr.)* |
| **Acres artificially drained** | 2,993,034 (13.9% imp. farm land) | |
| **Acres needing drainage** | 3,504,574 (11.6% all farm land) | |
| **Farms by size, number:** | | |
| Up to 19 acres | 6,160; | *5,619* |
| 20 " 49 " | 14,111; | *12,028* |
| 50 " 99 " | 32,743; | *26,571* |
| 100 " 174 " | 65,793; | *55,424* |
| 175 " 499 " | 56,353; | *52,836* |
| Over 500 " | 3,318; | *3,659* |
| Value all farm property | $3,787,420,118; | *$1,476,411,737* |
| Per cent increase in ten years | 156; | *87.2* |
| Value farm land | $2,750,328,432; | *$1,019,102,027* |
| " " buildings | $550,839,893; | *$243,339,399* |
| " " implements | $181,087,968; | *$52,329,165* |
| " " livestock | $305,163,825; | *$161,641,146* |
| Av. value all property per farm | $21,221; | *$9,456* |
| " " land and buildings per acre | $109.23; | *$45.62* |
| Farms run by owners | 132,744 (74.3%); | *122,104 (78.2%)* |
| Farms run by tenants | 44,138 (24.7%); | *32,811 (21%)* |
| Per cent owned farms unmortgaged | 40.7; | *53.3* |
| Per cent farms reporting automobiles 57.1; telephones 62. | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $506,020,233; | *$186,705,655* |
| " " cereals | $302,729,120; | *$140,864,148* |
| Corn, acres | 2,380,838; | *2,004,068* |
| production (bu.) | 84,786,096; | *67,897,051* |
| 10-yr. av. yield per acre | 34.7 bu. | |
| Wheat, acres | 3,793,402; | *3,276,971* |
| production (bu.) | 37,616,384; | *57,094,412* |
| 10-yr. av. yield per acre | 13.4 bu. | |
| Oats, acres | 3,429,079; | *2,977,258* |
| production (bu.) | 89,108,151; | *93,897,717* |
| 10-yr. av. yield per acre | 34.3 bu. | |
| Rye, acres | 649,609; | *266,567* |
| production (bu.) | 8,362,940; | *4,426,028* |
| 10-yr. av. yield per acre | 18.4 bu. | |
| Barley, acres | 814,381; | *1,573,761* |
| production (bu.) | 14,849,069; | *34,927,773* |
| 10-yr. av. yield per acre | 24.7 bu. | |
| Hay and forage, acres | 5,029,397; | *3,946,072* |
| production (tons) | 9,291,671; | *6,036,747* |
| value | $115,665,984; | *$26,730,202* |
| Potatoes, white, acres | 331,930; | *223,692* |
| production (bu.) | 26,690,056; | *26,802,948* |
| 10-yr. av. yield per acre | 104 bu. | |
| Maple sugar, trees tapped | 52,111; | *67,225* |
| sugar made (lbs.) | 3,146; | *11,399* |
| syrup made (gals.) | 12,870; | *17,808* |
| Small fruits, acres | 5,008; | *3,738* |
| production (quarts) | 6,165,120; | *4,476,575* |
| Strawberries, acres | 2,768; | *1,873* |
| production (quarts) | 4,111,969; | *2,730,099* |
| Vegetables, acres 14,652; value | $68,912,550; | *$11,044,391* |
| Apples, production (bu.) | 1,028,478; | *1,044,156* |
| Pears, production (bu.) | 265; | *400* |
| Peaches, production (bu.) | 370; | *599* |
| Plums and prunes (bu.) | 24,337; | *19,920* |
| Grapes, production (lbs.) | 141,278; | *293,805* |
| Forest products, value | $9,067,015; | *$5,181,508* |
| Nurseries: No. 132; acres 1,881; receipts | $774,060 | |
| Greenhouses: sq. ft. of glass 2,758,097; receipts | $1,387,168 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Farms reporting livestock | 173,034; | pure breds 32,227 |
| Value all livestock on farms | $305,163,825; | *$161,641,146* |
| Horses, number | 932,794; | *753,184* |
| value | $83,027,777; | *$89,068,872* |
| Mules, number | 10,238; | *5,775* |
| value | $1,062,973; | *$732,723* |
| All cattle, number | 3,021,469; | *2,347,435* |
| value | $151,243,703; | *$50,306,372* |
| Beef cattle, number | 940,842; | |
| Dairy cattle, number | 2,080,627; | *1,085,388* |
| Sheep, number | 509,064; | *637,582* |
| value | $5,748,518; | *$2,693,424* |
| Goats, number | 2,745; | *4,588* |
| value | $18,180; | *$18,480* |
| Swine, number | 2,380,862; | *1,520,257* |
| value | $52,245,873; | *$13,929,127* |
| Poultry, number | 13,663,443; | *10,697,075* |
| value | $11,405,427; | *$4,646,960* |
| Bees, number of hives | 67,344; | *56,677* |
| Livestock products, value | $113,236,965; | *$44,645,205* |
| Value all dairy products | $77,870,358; | *$29,219,406* |
| " eggs and chickens | $33,438,496; | *$14,482,329* |
| " wool and mohair | $1,559,256; | *$818,853* |
| " honey and wax | $368,855; | *$124,617* |
| Milk produced (gallons) | 475,506,689; | *273,319,603* |
| Butter made (lbs.) | 20,205,076; | *34,708,669* |
| Eggs produced (dozens) | 60,249,543; | *53,323,702* |

# MISSISSIPPI

**MISSISSIPPI** ("Bayou" or "Magnolia State") is one of the South Central and Gulf States, lying between 30 and 35 degrees north latitude, and 88 and 92 degrees west longitude. It is separated from Louisiana and Arkansas on the west by the Mississippi River. The Pearl River forms the western boundary of the southern part, and the Gulf of Mexico forms about half of the southern boundary. Big Black and Yazoo, tributary to the Mississippi, are the chief rivers. Others are the Pascagoula and the Pearl flowing to the Gulf. Area, 46,865 square miles, 503 of which are water.

**Land surface.** In general this is undulating or hilly. A broad, low ridge crossing the state from north to south forms the main divide. West of this the surface is broken by several narrow ridges and valleys which gradually sink to the level of the Yazoo Delta. This area is diversified by swamps, lakes, bayous and canebrakes. Farther south on the Mississippi, are bluffs which rise to a height of 200 to 500 feet. To the east of the divide, the uplands rise gradually from an elevation of 150 feet, a few miles from the coast, to a point in the northeast where some ridges reach an altitude of 600 feet. The entire drainage is directly or indirectly into the Gulf of Mexico. Several northeastern counties are typical prairie.

**Soils.** Most of the soils are yellow, brown or reddish loam, generally very fertile. The bottom lands are alluvial and very productive. The Yazoo Delta, between the Yazoo and Mississippi Rivers, the most fertile part of the Mississippi Valley, is protected along the course of the latter by more than 300 miles of levees.

**Climate.** That of the southern part is mild and subtropical. Average annual temperature for the whole state is 64 degrees. In the south, it is 67 degrees; on the northern border, 61 degrees. Average rainfall in the south is 54 inches; in the north, 49 inches; for the whole state, 51 inches. Light snowfalls sometimes reach as far south as Natchez. The summers are long and hot; the winters usually mild. The high percentage of humidity sometimes renders the heat oppressive. In the north, the highest recorded temperature is 108 degrees at Water Valley; the lowest, 13 degrees below zero at Louisville (this very exceptional); the frost-free season is 210 days. In the south, the highest recorded temperature is 109 degrees at Leakesville; lowest 10 degrees below zero at Brookhaven; and the frost-free season is about 240 days. The West Indian hurricanes sometimes cause considerable damage as do excessive rains, especially along the Gulf Coast.

**Opportunities.** Large areas of the cut-over lands in the southern part of the state are available at low prices. These lands are usually poor, but susceptible of improvement through the use of chemicals and green-manure crops. Information about these and other lands may be obtained from the Agricultural Experiment Station, Agricultural College.

**Products and industries.** Leading farm products are cotton (its value being 3 times as great as that of all the cereals), corn, sweet potatoes and yams, sugar cane, vegetables for northern markets, and fruits, especially peaches, strawberries and grapes. Livestock is represented mainly by beef cattle, swine and mules; dairying is increasing. Lumbering is extensive and important, the forest area being estimated at 30,000 square miles. Main manufactures are lumber and timber, cottonseed oil and cake, cotton goods, fertilizers, turpentine nd resin, canned fruits and vegetables.

**Transportation and markets.** Railroads are numerous, connecting with many of the great railway systems. The Mississippi River and its tributaries furnish important water communication as does the Gulf of Mexico through Gulfport, the principal port of entry; New Orleans, Louisiana, is an important market and shipping point for Mississippi.

**History.** The state is part of the Louisiana Territory. In 1539, De Soto crossed the northeastern part. In 1681-2, La Salle sailed down the Mississippi River to the Gulf, taking possession of the country in the name of the French crown and naming it Louisiana. In 1699, Iberville, with 200 French immigrants, established the first settlement near Biloxi, which was founded a dozen years later. In 1763, the French ceded the portion east of the Mississippi, except New Orleans, to the British. In 1798, Mississippi Territory was organized, embracing most of what is now southern Mississippi and Alabama. In 1817 Mississippi became a State, with its present limits. Ordinance of Secession passed January 9, 1861. Readmitted to the union, 1869. Capital, Jackson; population, 1910, 21,262. Mississippi has no really large cities, the largest being Meridian, 25,000, and Vicksburg, 20,000 (1910 figures).

**Agricultural organization.** Agricultural and Mechanical College and Experiment Station, *Agricultural College*. Branch stations at *Stoneville, Holley Springs, McNeill*; Alcorn Agricultural and Mechanical College, *Alcorn*; County Demonstration Agents, *Jackson*; Department of Agriculture and Commerce, *Jackson*. Livestock and Dairy Association, Horticultural Association, Hay Growers' Association, Farmers' Union, Nurserymen's Associaion, State Fair Association.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 1,790,618; | *1,797,114* |
| City | 240,121 (13.4%); | *207,311* (*11.5%*) |
| Country | 1,550,497 (86.6%); | *1,589,803* (*88.5%*) |
| Number of farmers | 272,101; | *274,382* |
| White | 110,882 (40.8%); | *109,645* (*40%*) |
| Non-white | 164,737 (59.2%); | *161,001* (*60.%*) |
| Land area, acres | 29,671,680 | |
| Acres in farms | 18,196,979; | *18,557,533* |
| Acres farm land improved | 9,325,677; | *9,008,310* |
| Average acres per farm | 66.8 (34.2 impr.); | *67.6* (*32.8* impr.) |
| Farm land artificially drained, acres | 825,878 (8.9% impr. farm land) | |
| Farm land needing drainage, acres | 1,455,534 (8% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 65,953; | *66,943* |
| 20 " 49 " | 116,795; | *112,666* |
| 50 " 99 " | 41,900; | *44,645* |
| 100 " 174 " | 28,218; | *30,172* |
| 175 " 499 " | 16,330; | *17,115* |
| Over 500 " | 2,905; | *2,841* |
| Value all farm property | $964,751,855; | *$426,314,634* |
| Per cent increase in ten years | 121; | *108.8* |
| Value farm land | $641,842,394; | *$254,002,289* |
| " " buildings | $148,054,384; | *$80,160,000* |
| " " implements | $39,881,256; | *$16,905,312* |
| " " livestock | $134,973,821; | *$75,247,03* |
| Av. value all property per farm | $3,546; | *$1,55* |
| " " land and buildings per acre | $43.41; | *$18.01* |
| Number farms run by owners | 91,310 (33.5%); | *92,066* (*30.2%*) |
| Number farms run by tenants | 179,802 (66.1%); | *181,491* (*66.1%*) |
| Per cent owned farms unmortgaged | 58.1; | *65.8* |
| Per cent farms reporting automobiles | 5.5 | |
| " " " " telephones | 8.4 | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $336,207,156; | *$140,531,671* |
| " " cereals | $71,484,048; | *$26,864,772* |
| Corn, acres | 2,657,009; | *2,172,612* |
| production (bu.) | 38,095,228; | *28,428,667* |
| 10-yr. av. yield per acre | 17.7 bu. | |
| Wheat, acres | 6,386; | *394* |
| production (bu.) | 54,685; | *4,670* |
| 10-yr. av. yield per acre | 14.2 bu. | |
| Oats, acres | 53,088; | *97,085* |
| production (bu.) | 760,417; | *1,268,785* |
| 10-yr. av. yield per acre | 19 bu. | |
| Rye, acres | 316; | *43* |
| production (bu.) | 2,525; | *516* |
| Cotton, acres | 2,948,38[illegible]; | *3,400,210* |
| production (bales) | 957,527; | *1,127,156* |
| 10-yr. av. yield per acre | 168 lbs. | |
| Hay and forage, acres | 485,544; | *229,705* |
| production (tons) | 585,254; | *279,236* |
| value | $14,744,951; | *$3,410,894* |
| Potatoes, white, acres | 8,993; | *8,342* |
| production (bu.) | 650,970; | *644,742* |
| 10-yr. av. yield per acre | 82 bu. | |
| Sweet, acres | 69,394; | *56,045* |
| production (bu.) | 6,550,500; | *4,427,988* |
| 10-yr. av. yield per acre | 94 bu. | |
| Peanuts, acres | 16,933; | *13,997* |
| production (bu.) | 241,601; | *284,791* |
| Sugar cane, acres | 25,256; | *24,861* |
| production (tons) | 186,283; | *222,600* |
| Sorghum, acres | 38,752; | *16,519* |
| production (tons) | 139,100; | *50,327* |
| Rice, acres | 1,171; | *281* |
| production (bu.) | 18,141; | *4,836* |
| 10-yr av. yield per acre | 29.5 bu. | |
| Small fruits, acres | 759; | *836* |
| production (quarts) | 1,389,203; | *1,407,301* |
| Strawberries, acres | 691; | *772* |
| production (quarts) | 1,323,461; | *1,345,013* |
| Vegetables, acres 14,015; value | $26,711,190; | *$9,483,576* |
| Apples, production (bu.) | 217,885; | *265,841* |
| Pears, production (bu.) | 120,744; | *101,288* |
| Peaches, production (bu.) | 775,885; | *1,156,817* |
| Plums and prunes (bu.) | 42,695; | *101,974* |
| Grapes, production (lbs.) | 507,899; | *760,563* |
| Forest products, value | $14,132,270; | *$6,602,943* |
| Nurseries: acres 147, in 37 establishments; receipts | $56,959 | |
| Greenhouses: sq. ft. under glass 260,786; receipts | $175,529 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 248,870; | pure breds 12,759 |
| Value all livestock on farms | $134,973,821; | *$75,247,033* |
| Horses, number | 214,852; | *216,220* |
| value | $22,921,665; | *$20,203,850* |
| Mules, number | 308,216; | *255,760* |
| value | $49,298,584; | *$32,028,421* |
| All cattle, number | 1,250,479; | *1,012,632* |
| value | $39,950,140; | *$15,269,364* |
| Beef cattle, number | 461,241; | |
| Dairy cattle, number | 789,238; | *429,587* |
| Sheep, number | 164,440; | *195,245* |
| value | $877,705; | *$416,716* |
| Goats, number | 113,277; | *45,871* |
| value | $291,225; | *$43,873* |
| Swine, number | 1,373,311; | *1,292,119* |
| value | $14,703,650; | *$4,913,166* |
| Poultry, number | 6,698,846; | *5,070,116* |
| value | $6,465,450; | *$1,846,751* |
| Bees, number of hives | 82,770; | *74,350* |
| Livestock products, value | $27,327,885; | *$13,127,660* |
| Value all dairy products | $11,772,201; | *$6,033,465* |
| " eggs and chickens | $15,132,499; | *$6,906,881* |
| " wool and mohair | $255,351; | *$122,452* |
| " honey and wax | $167,834; | *$64,862* |
| Milk produced (gallons) | 88,191,682; | *79,079,293* |
| Butter made (lbs.) | 20,758,736; | *28,730,685* |
| Eggs produced (dozens) | 23,783,265; | *20,337,062* |

# MISSOURI

**MISSOURI** ("Fair Weather State"), one of the Corn Belt States, lies between 36 and 41 degrees north latitude and 89 and 95 degrees west longitude. The Mississippi River forms the entire eastern boundary; its greatest tributary, the Missouri, flows for about 150 miles on the western boundary, then crosses the central part of the state, entering the Mississippi north of St. Louis. Other tributaries of the Mississippi are the St. Frances and the White, in the southern part. The Grand and Chariton Rivers flow into the Missouri from the north, and the Gasconade and Osage from the south. **Area,** 69,430 square miles, 693 of which are water.

**Land surface.** There are three general regions: (1) the upland plains of the northern and western part; (2) the Ozark Plateau region comprising most of the southwestern third of the state, and (3) the southeastern lowlands bordering the Mississippi River. The first includes all north of the Missouri River, and a large area south of it bordering Kansas, most of which is a rolling prairie broken by small strips of timber along the streams. The Ozark Plateau rises gradually from the Mississippi River in the southeastern part toward the south central part of the state, where it reaches an elevation of 1,500 feet and continues into Arkansas and Alabama. The surface is broken and hilly, although there are wide stretches of comparatively level uplands. The southeastern lowlands comprise an old flood plain of the Mississippi River, and contain numerous cypress swamps, lakes and lagoons, although about half of this is now drained and in farms.

**Soils.** The soils of the Prairie section are a rich, black loam in the northwest, somewhat lighter farther east. There is much loess soil along the Missouri River, especially in the northwestern part of the state. The Ozark Plateau has a flinty, clay limestone soil of only moderate fertility. The bottom lands of the rivers are mostly fertile. The extreme southeast, which originally was swampy, is now about half drained and it is mostly very productive.

**Climate.** Being an inland state, Missouri is subject to considerable extremes, but periods of excessive heat and cold are of short duration. In the north, the average annual temperature is 52.6 degrees. Highest recorded temperature is 114 degrees at Jefferson City; lowest, 29 degrees below zero at Bethany and Liberty. The average frost-free season is about 170 days. In southeastern Missouri, the highest recorded temperature is 116 degrees at Marble Hill; lowest, 32 degrees below zero at Greenville. The average frost-free season is about 200 days in the lowlands in the southeast, and about 175 days on the plateau. In the southwest, the average annual temperature is about 56 degrees. Highest recorded temperature is 112 degrees at Harrisonville; lowest, 35 degrees below zero at Arthur. The average frost-free season is about 175 days. The average annual rainfall is about 40 inches, being a little heavier in the east than in the west. There is an average snowfall of about 20 inches at St. Louis, and about 10 inches on the southern boundary.

**Opportunities.** Missouri has no land subject to homestead entry, but there are thousands of acres of unimproved land—somewhat broken uplands, cut-over timber tracts, and reclaimed lowlands—which can be bought very reasonably. Drainage projects are extensive in the southeastern lowlands, particulars of which may be obtained from the Bureau of Labor Statistics, Jefferson City.

**Products and industries.** Of the important farm products, corn is far in the lead. Cotton is grown in the extreme southeastern part. Hay, both tame and wild, wheat and oats are other leading crops. Of fruits, apples, peaches, strawberries and grapes are the leaders. Large numbers of beef cattle are produced, and dairying is increasing rapidly.

**Horses, mules, and swine are raised in large numbers, and poultry is an important product. Lumbering is still important in some of the counties south of the Missouri River. Leading minerals are lead, zinc and coal. Main manufactures are meat products, flour, tobacco, malt liquors, boots and shoes, lumber and timber products, clothing. Missouri leads the states west of the Mississippi River in the extent of manufactures. Chief industrial centers are St. Louis, Kansas City, St. Joseph, Hannibal and Joplin.**

**Transportation and markets.** Railroad facilities are excellent in the northern and western parts of the state and in the southeast lowlands, but fewer lines cover the Ozark region. St. Louis and Kansas City are among the most important railroad centers in the United States. There is a limited but increasing mileage of electric railways. Most important grain and livestock markets are St. Louis, Kansas City and St. Joseph.

**History.** Earliest settlements at St. Genevieve about 1735, and St. Louis in 1764. With the Territory of Louisiana, ceded to Spain by the Treaty of Paris, 1763; remained a Spanish possession till 1800, when it was ceded back to France. Louisiana Territory purchased by the United States in 1803. Organized as Missouri Territory, 1812. Admitted to statehood, 1821. Many Southern sympathizers during the Civil War, but Missouri remained in the Union. In 1904, the Louisiana Purchase Exposition was held at St. Louis to commemorate the 100th anniversary of the purchase of Louisiana. Capital, Jefferson City; population, 1910, 11,850.

**Agricultural organization.** The State University, College of Agriculture and Agricultural Experiment Station are located at *Columbia*. The College of Agriculture includes the Agricultural Extension Service and the Experiment Station, each with its own staff of workers in several departments. The Experiment Stations at *Mountain Grove* are independent of the University. The State Board of Agriculture is located at *Jefferson City*, as is also the Bureau of Labor Statistics.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population....................3,404.055; *3,293,335*
City.....1,586,903 (46.6%); *1,398,817 (42.5%)*
Country..1,817,152 (53.4%); *1,894,518 (57.5%)*
Number of farmers..................263,004; *277,244*
White...260,178 (98.9%); *273,578 (98.7%)*
Non-white.....2,826 (1.1%); *3,666 (1.3%)*
Land area, acres..............................43,985,280
Acres in farms..................34,774,679; *34,591,248*
Acres farm land improved........24,832,966; *24,581,186*
Av. acres per farm 132 (94 impr.); *124.8 (88 impr.)*
Acres artificially drained 859,663 (3.5% imp. farm land)
Acres needing drainage...830,693 (2.4% all farm land)
Farms by size, number:
Up to 19 acres.....................16,641; *19,756*
20 " 49 " .....................41,116; *47,398*
50 " 99 " .....................67,446; *74,178*

Farms by size, number: (*Continued*)
100 " 174 " .....................79,507; *80,020*
175 " 499 " .....................53,961; *51,921*
Over 500 " .....................4,333; *3,971*
Value all farm property...$3,591,068,085; *$2,052,917,488*
Per cent increase in ten years................74.8; *98.7*
Value farm land.........$2,594,193,271; *$1,445,982,389*
" " buildings..... $468,774,429; *$270,221,997*
" " implements... $138,261,340; *$50,873,994*
" " livestock..... $389,839,045; *$285,839,108*
Av. value all property per farm.........$13,654; *$7,405*
" " land and buildings per acre.....$88.08; *$49.61*
Farms run by owners..185,030 (70.3%); *192,285 (69.1%)*
Farms run by tenants..75,727 (28.8%); *82,958 (29.9%)*
Per cent owned farms unmortgaged..........44.4; *53.3*
Per cent farms reporting automobiles 30.9; telephones 62.2

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops.........$559,047,854; *$211,001,359*
" " cereals...........$394,195,226; *$147,980,414*
Corn, acres.............. 5,567,079; *7,113,953*
production (bu.).... 146,342,036; *191,427,087*
10-yr. av. yield per acre................26 bu.
Wheat, acres............ 4,564,990; *2,017,128*
production (bu.).... 65,210,462; *29,837,429*
10-yr. av. yield per acre..............14.2 bu.
Oats, acres.............. 1,707,055; *1,073,325*
production (bu.).... 40,493,700; *24,828,501*
10-yr. av. yield per acre..............26.8 bu.
Rye, acres.............. 107,422; *20,001*
production (bu.).... 917,673; *205,813*
10-yr. av. yield per acre..............13.5 bu.
Cotton, acres............ 110,027; *96,527*
production (bales).. 63,808; *54,498*
10-yr. av. yield per acre..............256 lbs.
Hay and forage, acres....... 4,206,473; *3,628,348*
production (tons)... 5,687,127; *4,091,342*
value............. $95,897,050; *$34,007,292*
Barley, acres.............. 8,930; *7,915*
production.......... 145,496; *134,253*
10-yr. av. yield per acre..............24.4 bu.
Potatoes, white, acres....... 66,015; *96,259*
production (bu.).... 4,057,753; *7,796,410*
10-yr. av. yield per acre................66 bu.
Sweet, acres............. 11,165; *7,938*
production (bu.).... 997,606; *876,234*
10-yr. av. yield per acre................91 bu.
Peanuts, acres............. 261; *130*
production (bu.).... 2,463; *3,220*
Tobacco, acres............. 4,490; *5,433*
production (lbs.).... 4,074,977; *5,372,738*
Sorghum, acres............ 33,771; *37,476*
production (tons)... 115,690; *176,765*
Buckwheat, acres.......... 1,119; *1,676*
production (bu.).... 11,165; *20,289*
Small fruits, acres.......... 16,768; *17,009*
production (quarts). 17,769,936; *23,696,221*
Strawberries, acres.......... 8,645; *9,048*
production (quarts). 12,861,820; *15,171,034*
Vegetables, acres 28,838: value $30,556,949; *$13,305,829*
Apples, production (bu.)..... 5,132,109; *9,258,977*
Pears, production (bu.)...... 430,838; *142,547*
Peaches, production (bu.).... 1,262,723; *1,484,548*
Plums and prunes (bu.)...... 232,025; *234,872*
Grapes, production (lbs.).... 10,949,602; *17,871,816*
Forest products, value....... $13,938,458; *$8,406,823*
Nurseries: No. 139; acres 1,194 receipts .....$1,045,697
Greenhouses: sq. ft. of glass 5,099,019; receipts. $2,229,808

### 3. Livestock, 1920 and *1910*

Farms reporting
livestock............ 256,236; pure breds 38,374
Value all livestock on farms..$389,839,045; *$285,839,108*
Horses, number.......... 906,220; *1,073,387*
value............ $74,482,800; *$113,976,563*
Mules, number........... 389,045; *342,700*
value............ $50,971,253; *$43,438,702*
All cattle, number........ 2,781,644; *2,561,482*
value.............$158,976,138; *$72,883,664*
Beef cattle, number..... 1,714,894;
Dairy cattle, number.... 1,066,750; *856,430*
Sheep, number........... 1,271,616; *1,811,268*
value............ $15,755,632; *$7,888,878*
Goats, number........... 121,012; *72,415*

| | | |
|---|---|---|
| Goats, value | $558,520; | *$187,409* |
| Swine, number | 3,888,677; | *4,438,194* |
| value | $61,555,706; | *$31,937,575* |
| Poultry, number | 25,610,515; | *20,897,208* |
| value | $25,470,023; | *$11,870,972* |
| Bees, number of hives | 157,678; | *203,569* |
| Livestock products, value | $105,601,436; | *$49,839,077* |
| Value all dairy products | $34,752,845; | *$13,685,318* |
| " eggs and chickens | $66,271,029; | *$33,918,187* |
| " wool and mohair | $4,217,400; | *$1,961,398* |
| " honey and wax | $360,162; | *$274,174* |
| Milk produced (gallons) | 228,907,721; | *188,297,972* |
| Butter made (lbs.) | 29,470,763; | *42,105,143* |
| Eggs produced (dozens) | 117,203,569; | *110,922,152* |


# MONTANA

**MONTANA** ("Copper State"), a Western State, lies between 44 and 49 degrees north latitude, and 104 and 116 degrees west longitude. Its extreme dimensions are 315 miles north to south, and 580 miles from east to west. It ranks third in size among all the states, the area being 146,572 square miles, of which 796 are water.

**Land surface.** The main chain of the Rocky Mountains, with peaks reaching 8,000 to 11,300 feet, extends from Yellowstone Park (at about the middle of the southern border) northwest across the state. The country east of this, covering about two thirds of the state, is in the plains region, and consists mainly of rolling table lands varying from 4,000 feet above sea level at the base of the mountains to 2,000 feet in the northeast corner. This region is drained by the Missouri River formed by the junction of the Jefferson, Madison and Gallatin forks. The Bitter Root Mountains (7,000 to 8,000 feet high) lie along the state's southwestern boundary, and the western third of the state, between these and the Rockies, consists of a great basin drained by the Clark Fork of the Columbia River, with its two branches—the Missoula and the Flathead.

**Soils.** The southeastern part of the state consists largely of upland soils formed by the breaking down of underlying rock, and by the partial weathering of large deposits of sandy and gravelly loams which have been brought down from the western mountain region. In the western part, the soils of the broad valleys are dark-colored alluvial silts, and sandy loams; the bench lands and terraces bordering the valleys are sandy and gravelly, while those of the higher portion bordering the mountains have generally a good soil. The intensive farming is largely on the alluvial soils of the river valleys, much of it under irrigation, but even larger areas are cropped by dry-farming methods; the table lands are lighter and sandy, the best being good for dry-farming and all of them good for grazing. On the "bad lands," which are interspersed through the eastern portion of the state and mainly along the water courses, the soil is too steep for anything but grazing. Grain can be grown in most parts of the state without irrigation.

**Climate.** This is marked by great extremes of heat and cold, but is generally healthful. The varying altitudes, the mountain barriers and deep valleys which deflect air currents, the cold waves from the Canadian Northwest, and the warm Chinook winds from the Pacific, all combine to cause a great variety of climate, often sudden and extreme changes in temperature, and wide differences in prevalence of, or freedom from, severe storms. Temperatures as high as 117 degrees and as low as 65 degrees below zero have been recorded. The average annual temperature varies from 40 to 45 degrees in different locations. Average annual rainfall varies from 10 to 33 inches in different sections, and the average frost-free season from 50 to 150 days. The snowfall varies, also, but is usually heavy in most parts of the state.

**Opportunities.** About one third of the farms of the state are irrigated, and the number is being constantly increased. Information about farms available under the reclamation projects may be obtained from the U. S.

Reclamation Service, Washington, D. C. Dry-farming areas are being enlarged and crops thus grown are being increased annually. Experiments in irrigation by pumping from wells have been conducted by the Experiment Station.

**Products and industries.** Leading farm activities are the production of hay, spring wheat and oats. Apples are successfully grown. The leading livestock are sheep, in which Montana leads. Beef cattle and horses come next. Hogs and dairy cattle are increasing rapidly. Lumbering is carried on in the mountainous portions. Leading minerals are gold, silver, copper and lead, which form the greatest source of wealth in the state, and coal. Sapphires of unusual quality constitute the most valuable deposit of precious stones discovered in this country. Manufacturing has not been developed to any great extent, except the refining and smelting of copper and lead, but the available water power and extensive coal deposits give opportunity for almost unlimited development.

**Transportation and markets.** Being a new state, its railroads are not extensive. Three transcontinental lines, however, connect all important centers with the Pacific Coast and the East. The Oregon Short Line connects at Butte with Idaho and Utah and the states to the south, and the Burlington connects with the Southeast. The Missouri River is navigable to Fort Benton and the Yellowstone to the mouth of the Big Horn.

**History.** First explored in 1742. In 1805, the Lewis and Clark expedition explored the Yellowstone and Missouri rivers. Trading posts were established along the Yelllowstone from 1809 to 1829. Fort Benton founded in 1846. Discovery of gold in 1852 led to the country's first development. The Montana region was organized in 1860–1 as Shoshone and Missoula Counties of Washington Territory. In 1863, Idaho and Montana were set off from Washington under the name of Idaho Territory. In 1864, Montana was established as a separate territory with the capital at Virginia City. In 1874 the capital was removed to Helena. The Northern Pacific Railway was completed in 1883. A constitution was adopted in 1884, and Montana was admitted to statehood in 1889.

**Agricultural organization.** College of Agriculture and Mechanic Arts, and Experiment Station, Coöperative Demonstration Work, all *Bozeman*; Horticultural Substation, *Corvallis*; Horticultural Society, *Missoula*; Fish and Game Protective Association, *Helena*. The State Fair is held at *Helena*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 548,889; | *376,053* |
| City | 172,011 (31.3%); | *133,420 (35.5%)* |
| Country | 376,878 (68.7%); | *242,633 (64.5%)* |
| Number of farmers | 57,677; | *26,214* |
| White | 56,614 (98.2%); | *25,018 (95.4%)* |
| Non-white | 1,063 (1.8%); | *1,196 (4.6%)* |
| Land area, acres | 93,568,640 | |
| Acres in farms | 35,070,656; | *13,545,603* |
| Acres farm land improved | 11,007,278; | *3,640,309* |
| Average acres per farm | 608 (190 impr.); | *516 (139 impr.)* |
| Farm land artificially drained, acres | 51,146 (.5% impr. farm land) | |
| Farm land needing drainage, acres | 113,293 (.3% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 930; | *755* |
| 20 " 49 " | 1,279; | *956* |
| 50 " 99 " | 2,141; | *1,260* |
| 100 " 174 " | 8,735; | *10,552* |
| 175 " 499 " | 26,988; | *8,339* |
| Over 500 " | 17,604; | *4,352* |
| Value all farm property | $985,961,308; | *$347,828,770* |
| Per cent increase in ten years | 183.5; | *95.1* |
| Value farm land | $691,912,265; | *$226,771,302* |
| " " buildings | $84,855,264; | *$24,854,628* |
| " " implements | $55,004,212; | *$10,539,653* |
| " " livestock | $154,189,567; | *$85,663,187* |
| Av. value all property per farm | $17,095; | *$13,269* |
| " " land and buildings per acre | $22.15; | *$18,58* |
| Number farms run by owners | 50,271 (87.1%); | *23,365 (89.1%)* |
| Number farms run by tenants | 6,507 (11.3%); | *2,344 (8.9%)* |
| Per cent owned farms unmortgaged | 32.6; | *77.1* |

Per cent farms reporting automobiles 36; telephones 17.

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $69,975,185; | *$28,886,689* |
| " " cereals | $22,432,106; | *$12,251,34* |
| Corn, acres | 18,717; | *9,514* |
| production (bu.) | 159,410; | *274,103* |
| 10-yr. av. yield per acre | 23.2 bu. | |
| Wheat, acres | 1,698,531; | *258,377* |
| production (bu.) | 7,799,647; | *6,251,945* |
| 10-yr. av. yield per acre | 18.2 bu. | |
| Oats, acres | 191,096; | *333,195* |
| production (bu.) | 2,583,908; | *13,805,735* |
| 10-yr. av. yield per acre | 35.4 bu. | |
| Rye, acres | 75,979; | *6,034* |
| production (bu.) | 227,948; | *111,214* |
| 10-yr. av. yield per acre | 17.1 bu. | |
| Barley, acres | 29,330; | *27,242* |
| production (bu.) | 346,972; | *753,268* |
| 10-yr. av. yield per acre | 25.8 bu. | |
| Hay and forage, acres | 1,675,472; | *1,135,376* |
| production (tons) | 1,382,946; | *1,692,656* |
| value | $36,115,771; | *$12,348,150* |
| Potatoes, white, acres | 22,178; | *20,170* |
| production (bu.) | 1,659,017; | *3,240,696* |
| 10-yr. av. yield per acre | 128 bu. | |
| Buckwheat, acres | 422; | *84* |
| production (bu.) | 1,412; | *1,809* |
| Sugar beets, acres | 8,600; | *8,710* |
| production (tons) | 73,824; | *108,776* |
| Small fruits, acres | 386; | *562* |
| production (quarts) | 338,087; | *766,791* |
| Strawberries, acres | 155; | *265* |
| production (quarts) | 171,150; | *406,038* |
| Vegetables, acres 1,273; value | $5,982,389; | *$2,227,736* |
| Apples, production (bu.) | 671,716; | *561,054* |
| Pears, production (bu.) | 3,960; | *7,543* |
| Peaches, production (bu.) | 509; | *128* |
| Plums and prunes (bu.) | 9,575; | *8,777* |
| Grapes, production (lbs.) | 2,066; | *370* |
| Forest products, value | $1,253,217; | *$541,800* |
| Nurseries: acres 95 in 23 establishments: receipts | $34,582 | |
| Greenhouses: sq. ft. under glass 843,942; receipts | $525,128 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 54,017; | pure breds 7,142 |
| Value all livestock on farms | $154,189,567; | *$85,663,187* |
| Horses, number | 668,723; | *315,956* |
| value | $48,277,891; | *$27,115,764* |
| Mules, number | 9,462; | *4,174* |
| value | $1,119,630; | *$445,278* |

| | | |
|---|---|---|
| All cattle, number | 1,268,516; | *943,147* |
| value | $73,938,253; | *$27,474,122* |
| Beef cattle, number | 1,057,418; | |
| Dairy cattle, number | 211,098; | *77,527* |
| Sheep, number | 2,082,919; | *5,380,746* |
| value | $25,775,607; | *$29,028,069* |
| Goats, number | 1,282; | *5,045* |
| value | $12,410; | *$22,416* |
| Swine, number | 167,060; | *99,261* |
| value | $2,888,694; | *$858,829* |
| Poultry, number | 2,127,854; | *966,690* |
| value | $1,994,289; | *$628,436* |
| Bees, number of hives | 11,918; | *6,313* |
| Livestock products, value | $24,809,029; | *$12,749,555* |
| Value all dairy products | $7,534,413; | *$2,093,594* |
| " eggs and chickens | $6,883,213; | *$2,408,216* |
| " wool and mohair | $10,231,133; | *$8,225,810* |
| " honey and wax | $160,270; | *$21,935* |
| Milk produced (gallons) | 51,251,095; | *16,982,145* |

**Livestock products** (*Continued*): [1]

| | | |
|---|---|---|
| Butter made (lbs.) | 5,961,336; | *2,830,674* |
| Eggs produced (dozens) | 11,858,042; | *5,950,016* |

**4. Irrigation, 1920 and *1910***

| | |
|---|---|
| Acres in irrigated projects | 4,329,148; *3,515,602* |
| " of projects irrigable | 2,753,498; *2,205,155* |
| " " " irrigated | 1,681,729; *1,679,084* |
| " " irrigated land open to settlement | 207,530 |
| Capital invested in projects | $52,143,363; *$22,970,958* |
| Average investment, per acre | $18.94; *$10.42* |
| Estimated final cost | $70,079,028; *$32,382,077* |
| Average cost per acre | $16.19; *$9.21* |
| " " maintainance and operation, per acre | $1.26; *$0.89* |
| Acres of crops on irrigated land | 867,226 |
| Value of crops on irrigated land | $30,382,674 |
| Av. value crops on irrigated land, per acre (1919) | $35.03 |


# NEBRASKA

**NEBRASKA** ("Antelope State"), one of the North Central States, lies between 40 and 43 degrees north latitude, and 95 and 104 degrees west longitude. The Missouri River forms part of the northern and all of the eastern boundary. Area, 77,510 square miles, of which 702 are water surface.

**Land surface.** The state is largely a gently rolling plain, with a gradual upward slope from east to west. In the north and west are the foothills of the Rocky Mountains, ranging from 3,500 to 5,084 feet in height. In the Missouri Valley in the east, the elevation is less than 850 feet above sea level. The river valleys are mostly shallow and, in the case of the larger rivers, very broad.

Soils. These are largely loess. Most of the northern two thirds of the state has a dark-brown silt loam soil, very fertile and adapted to corn, oats and grass. Some of the river valleys are timbered and their soil is darker and adapted to grass and wheat. The southern part consists largely of a gray silt loam adapted to fruits, especially apples, and general farm crops. Along the streams the soil is largely alluvial and very fertile. Through the north central part run the Sand Hills, and west of this the high plains country adapted to dry-farming.

**Climate.** The winters are usually severe and the summers hot, but on account of the dry atmosphere, these extremes are not so severely felt as in a moister climate. Temperatures and rainfall vary widely in different sections. In southern Nebraska, the average annual temperature is about 50 degrees; the average frost-free season about 160 days; and the average annual rainfall from about 32 inches in the eastern to 16 inches in the western part. In the northeastern section, the average annual temperature is about 48; the average frost-free season 150 days; and the average annual rainfall decreases from 30.5 inches in the eastern portion to 22.5 in the western. In the northwestern section, average annual temperature is 47 degrees; the frost-free season only about 132 days; and the average annual rainfall about 20 inches. The snowfall varies with the season from almost nothing in certain years to about 24 inches in the east, to 30 inches in the west in years of heavy snowfall. Considerably more than half the days of the year are clear, and relatively few are rainy.

**Opportunities.** In the western half of Nebraska, the climate and the land are ideal for irrigation, and the entire valley of the North Platte will, in a few years, be under canals leading from the great Pathfinder reservoir in the Wyoming mountains. The two largest ir-

rigation projects are the Interstate Canal and the Fort Laramie Canal. Both derive their waters from the Pathfinder Reservoir. The Interstate Canal irrigates about 150,000 acres on the north side of the Platte in Nebraska. The Fort Laramie Canal, under construction, will irrigate about 80,000 acres. Both of these were constructed by the United States Government. Besides these larger projects, are several hundred smaller ones with an aggregate of over 600,000 acres subject to irrigation and the prospect that ultimately 1,000,000 acres will be brought under irrigation. Information may be obtained from the Reclamation Service, Washington, D. C. The Niobrara National Forest Reserve is in Cherry County, 123,779 acres. Bessey National Forest Reserve in Thomas County, 85,123 acres.

**Products and industries.** Nebraska is preeminently an agricultural state. Leading farm activities are the production of cereals and livestock. Corn is the leading cereal, exceeding all others in acreage and value. It is grown most largely in the east, and much of it is fed on the farms to range cattle, sheep and swine. Winter wheat is extensively grown. Barley, oats, emmer and spelt are grown throughout the state, and durum wheat in the west. Immense quantities of hay and forage are produced, and potatoes are important. Apples and grapes are the leading fruits in the eastern counties. Large areas of sugar beets are grown in the irrigated sections. Cattle lead in value of farm animals, followed by horses, swine and mules; poultry exceed sheep in value. Manufacturing is developing rapidly; main lines are meats; flour and other cereal products; butter, cheese and condensed milk; railroad cars; lumber and timber products; leather goods, and clothing. The leading manufacturing city is Omaha.

**Transportation and markets.** The state is fairly well covered by railroads. Omaha is a port of entry, the leading market city and the seat of the slaughtering and packing industry.

**History.** Nebraska belonged to that part of the Louisiana Purchase which, in 1804, was organized as the Territory of Louisiana and, after 1812, was known as Missouri Territory. Some explorations were made by the Lewis and Clark expedition in 1804–6. First permanent settlement was a trading post at Bellevue, about 1823. Fort Atkinson was established in 1819, abandoned in 1827; Omaha was settled in 1850, and Nebraska City in 1847. In 1854, Congress passed a bill organizing the territory north of 40 degrees north latitude as Nebraska Territory. After numerous boundary changes, the state was admitted to the Union in 1867. In 1898, the Trans-Mississippi Exposition was held at Omaha.

**Agricultural organizations.** College of Agriculture and Experiment Station, Coöperative Demonstration Work, *Lincoln;* Board of Agriculture, State Horticultural Society, Dairymen's Association, Poultry Association, Corn Improvers' Association, Improved Live Stock Breeders' Association, all *Lincoln.* Each of the above associations receives appropriations from the State Treasury for its work. Live Stock Sanitary Board, Food, Drug, Dairy and Oil Commission, *Lincoln.* State Fair held permanently at *Lincoln.*

The Experiment Station Director reports that the most decided tendency and progress along agricultural lines in Nebraska is in the field of economic distribution. About 50,000 farmers are members of associations whose functions include coöperative buying and selling. In the field of production, the most pronounced features of progress are five: (1) The development in the western part of Nebraska of an extensive commercial potato industry, both under irrigation and dry-farming, which has more than doubled the product within a few years and greatly enlarged the possibilities of that region. (2) The construction of 2 new beet-sugar factories in the irrigated district of western Nebraska, involving an expenditure of several million dollars and signifying the permanence of sugar beets as a staple product of that section. (3) The practical end of the public land period in Nebraska by the homesteading of almost the last acreage in the Sand Hill section under the 640-acre homestead law. (4) The sudden development of the manufacture of potash from alkali lakes in the Sand Hill region; these lakes have suddenly been discovered to be worth millions of dollars, and within a year probably $5,000,000 of capital went into their development; dividends running as high as 1,000 per cent have been paid upon these investments. (5) The sudden rise of oat production which has become one of the major industries of Nebraska, due to extensive killing of winter wheat and planting of large acreage to oats in 1917, which gave phenomenal returns in both yield and price.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | |
|---|---|
| **Population** | 1,296,372; *1,192,214* |
| City | 405,306 (31.3%); *310,852 (26.1%)* |
| Country | 891,066 (68.7%); *881,362 (73.9%)* |
| **Number of farmers** | 124,417; *129,678* |
| White | 124,033 (99.7%); *129,216 (99.6)* |
| Non-white | 384 (0.3%); *462 (0.4)* |
| **Land area, acres** | 49,157,120 |
| **Acres in farms** | 42,225,475; *38,622,021* |
| Acres farm land improved | 23,109,624; *24,382,577* |
| Av. acres per farm | 339 (185 impr.); *297.8* (*188* impr.) |
| Acres artificially drained | 214,428 (.9% impr. farm land) |
| Acres needing drainage | 145,818 (.3% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 3,361; *4,358* |
| 20 " 49 " | 3,701; *4,558* |
| 50 " 99 " | 11,163; *12,618* |
| 100 " 174 " | 43,157; *43,916* |
| 175 " 499 " | 47,377; *47,233* |
| Over 500 " | 15,658; *16,995* |
| Value all farm property | $4,201,655,992; *$2,079,818,647* |
| Per cent increase in ten years | 102; *178.1* |
| Value farm land | $3,330,222,340; *$1,614,539,313* |

| | | |
|---|---|---|
| Value farm buildings | $381,885,420; | *$198,807,622* |
| " " implements | $153,104,448; | *$44,249,708* |
| " " livestock | $336,443,784; | *$222,222,004* |

Av. value all property per farm........$33,771; *$16,038*
" " land and buildings per acre.....$87.91; *$46.95*
Farms run by owners....69,672 (55.9%); *70,250 (54.1%)*
Farms run by tenants...53,430 (42.9%); *49,441 (38.1%)*
Per cent owned farms unmortgaged..........38.8; *59.9*
Per cent farms reporting automobiles 75.6; telephones 76.4

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $519,729,771; | *$194,401,937* |
| " " cereals | $395,917,589; | *$153,666,652* |
| Corn, acres | 6,699,450; | *7,266,057* |
| production (bu.) | 160,391,314; | *180,132,807* |
| 10-yr. av. yield per acre | | 24.5 bu. |
| Wheat, acres | 4,294,156; | *2,662,918* |
| production (bu.) | 57,843,598; | *47,685,745* |
| 10-yr. av. yield per acre | | 16.1 bu. |
| Oats, acres | 2,029,740; | *2,365,774* |
| production (bu.) | 59,819,545; | *53,360,185* |
| 10-yr. av. yield per acre | | 29.2 bu. |
| Rye, acres | 359,926; | *62,827* |
| production (bu.) | 3,259,390; | *660,631* |
| 10-yr. av. yield per acre | | 15.2 bu. |
| Barley, acres | 211,242; | *113,571* |
| production (bu.) | 4,405,323; | *1,987,516* |
| 10-yr. av. yield per acre | | 22.9 bu. |
| Hay and forage, acres | 5,410,808; | *4,520,034* |
| production (tons) | 6,619,001; | *5,776,475* |
| value | $96,965,224; | *$31,783,373* |
| Potatoes, white, acres | 94,247; | *111,151* |
| production (bu.) | 4,452,497; | *8,117,775* |
| 10-yr. av. yield per acre | | 76 bu. |
| sweet, acres | 274; | *279* |
| production (bu.) | 25,536; | *28,500* |
| Buckwheat, acres | 1,598; | *1,205* |
| production (bu.) | 17,433; | *9,876* |
| 10-yr. av. yield per acre | | 17.2 bu. |
| Sugar beets, acres | 54,486; | *4,182* |
| production (tons) | 554,646; | *39,756* |
| Flaxseed, acres (1920) | 5,000 | |
| production (bu.) | 45,000; | |
| Small fruits, acres | 1,147; | *1,411* |
| production (quarts) | 647,321; | *1,594,421* |
| Strawberries, acres | 754; | *562* |
| production (quarts) | 451,798; | *654,061* |
| Vegetables, acres 14,823; value | $17,040,475; | *$5,931,738* |
| Apples, production (bu.) | 907,224; | *3,321,073* |
| Pears, production (bu.) | 24,617; | *6,700* |
| Peaches, production (bu.) | 11,461; | *110,180* |
| Plums and prunes, (bu.) | 11,537; | *41,910* |
| Grapes, production (lbs.) | 2,404,035; | *4,752,217* |
| Forest products, value | $933,276; | *$795,053* |

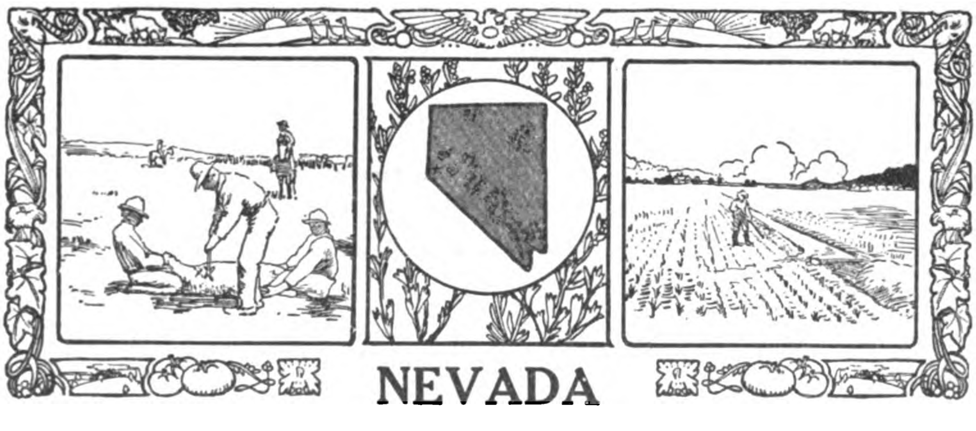
Nurseries: no. 30; acres 235; receipts..........$98,400
Greenhouses: sq. ft. of glass 1,041,665; receipts, $603,684

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Farms reporting livestock | 121,870; | pure breds 25,472 |
| Value all livestock on farms | $336,443,784; | *$222,222,004* |
| Horses, number | 961,396; | *1,008,378* |
| value | $72,306,803; | *$102,804,907* |
| Mules, number | 99,847; | *83,405* |
| value | $11,690,082; | *$10,374,076* |
| All cattle, number | 3,154,265; | *2,932,350* |
| value | $163,683,769; | *$73,074,057* |
| Beef cattle, number | 2,464,557; | |
| Dairy cattle, number | 689,708; | *613,952* |
| Sheep, number | 573,217; | *293,500* |
| value | $5,926,861; | *$1,486,948* |
| Goats, number | 2,286; | *3,290* |
| value | $12,807; | *$11,945* |
| Swine, number | 3,435,690; | *3,435,724* |
| value | $72,071,506; | *$29,649,482* |
| Poultry, number | 11,932,243; | *9,351,830* |
| value | $10,222,546; | *$4,219,158* |
| Bees, number of hives | 40,971; | *45,625* |
| Livestock products, value | $54,612,075; | *$24,961,343* |
| Value all dairy products | $23,706,963; | *$10,566,275* |
| " eggs and chickens | $29,500,431; | *$13,856,885* |
| " wool and mohair | $1,230,427; | *$464,785* |
| " honey and wax | $174,254; | *$73,398* |
| Milk produced (gallons) | 168,083,367; | *160,610,359* |
| Butter made (lbs.) | 13,761,085; | *25,986,931* |
| Eggs produced (dozens) | 49,132,437; | *46,460,624* |

### 4. Irrigation, 1920 and *1910*

Acres in irrigated projects.............766,768; *680,133*
" of projects irrigable.............562,468; *429,285*
" " " irrigated.............442,690; *255,950*
" " irrigated land open to settlement.......
Capital invested in projects.....$13,909,185; *$7,798,310*
Average investment, per acre............$24.73; *$18.17*
Estimated final cost............$18,030,154; *$9,485,231*
Average cost per acre..................$23.51; *$13.95*
Average cost maintenance and operation, per acre...................... $1.48; *$1.09*
Acres of crops on irrigated land................199,815
Value of crops on irrigated land............$11,547,679
Av. value crops on irrigated land, per acre (1919) $57.79



# NEVADA

**NEVADA** ("Sagebrush State"), one of the western mountain states, lies between 35 and 42 degrees north latitude, and 114 and 120 degrees west longitude. The Colorado River forms the southeastern boundary for about 150 miles. Aside from this river, the streams of the state mostly disappear in the sands, or flow into lakes with no visible outlets, some of which are salty or alkaline.

**Land surface.** Nearly the whole state is in the tableland known as the Great American Basin, with an average elevation of

4,000 to 5,000 feet. This is included between the Wasatch Mountains on the east and the Sierra Nevadas on the west. The basin is crossed from north to south by parallel ridges of mountains, some with elevations of 6,000 feet above the general level of the plateau; the highest elevation in the State is Wheeler Peak, 13,058 feet above sea level. The ridges are separated by long, narrow valleys. Parts of these valleys are alkaline deserts. The remainder are covered with sagebrush interspersed with native grasses which afford grazing for about 500,000 cattle and 1,500,000 sheep. The latter, comprising perhaps 70 per cent. of the valley area, offer greater or less promise of ultimate reclamation.

Soils. These, for the most part, are alluvial, sandy or gravelly loams deposited in the valleys by mountain erosion, and to a lesser degree, by the streams. In the ancient Lake Lahontan basin, the soils are in part volcanic ash intermixed with clays, and loams deposited as lake sediment. Soils covered with sagebrush are usually rich in plant foods, and are very productive under irrigation.

Climate. There is a wide range in temperature between the elevated northern part and the sub-tropical southern part. Wide daily ranges of temperature are experienced, due to lack of atmospheric humidity; the nights, as a rule, even in the hottest weather, are cool. Records of 39 degrees below zero have been recorded at Beowawe and of 117 degrees at Logan, in southern Nevada, but these may be regarded as exceptions. Northeastern Nevada has a somewhat severer winter climate than the central and western parts where comparatively mild winters prevail. In parts of southern Nevada, zero weather is unknown and freezing weather rare. Average annual temperatures range from 45.5 degrees in the northern section, to 64.9 degrees in the southern. Although instances of killing frosts in the north have been recorded in almost every month in the year, the normal growing season of crops is about 5 months, and the loss from frost is unimportant. The average rainfall, principally snow in winter, is less than 10 inches. As a whole, the climate is temperate, extremely dry, and healthful and invigorating.

**Opportunities.** Agricultural opportunities are presented in the settlement of the U. S. Truckee-Carson Reclamation Project, at Fallon; in the subdivision of the large irrigated ranches; and in homesteading arable public lands. Improved farm lands range in value from $75 to $300 per acre. Information about these lands may be obtained from the Agricultural Extension Division, Experiment Station, Reno.

**Products and industries.** Nevada is popularly regarded as strictly a mining state. Agriculture, however, has advanced so rapidly in recent years that, in 1917, an agricultural production in excess of $40,000,000 almost equaled the mineral production. Forage crops combined with livestock represent the ordinary type of farming. The sugar-beet industry has been successfully established with 1 large factory in operation. Dairying is increasing. While the hardy fruits are grown in northern Nevada, little attention is given to orcharding. In southern Nevada, the cantaloupe industry has developed to some proportions, and almonds, figs, pomegranates, grapes and other tender fruits are profitably grown. Potatoes are an important crop, the only one exported in any quantity. Gold, silver, copper, lead, zinc, tungsten and mercury are the most important minerals. Manufacturing is limited to foundry, machine-shop, flour, lumber, planing-mill and dairy products.

**Transportation and markets.** The state is traversed by three transcontinental railroad systems. Branch and local lines reach most of the settled portions. Farm crops, for the most part, are converted into livestock products which are exported to the Pacific Coast markets.

**History.** John C. Fremont led an exploring party through Nevada in 1843–4, and the first settlements were made by the Mormons in the valley of the Carson River, 1849. By the treaty of Guadalupe Hidalgo, which closed the Mexican War, the territory became a part of the U. S. in 1848. The region between 37 and 45 degrees north latitude and extending westward from the Rocky Mountains to California, was organized as Utah Territory in 1850, and in 1861, the territory of Nevada was organized. In 1864, this was admitted to statehood. Because of the decline in silver mining, the population of the state decreased during the latter part of the last century, but has recovered since. Population in 1917, estimated, 105,000. Capital, Carson City; population, 1910, 2,466.

**Agricultural organization.** The College of Agriculture, University of Nevada, *Reno*, comprises the Agricultural Extension Division, Agricultural Experiment Station, and Animal Disease Control Service. The State Fair is held annually at *Fallon*. County organizations comprise farm bureaus, county agricultural agents, home demonstrators and boys' and girls' club leaders, under direction of the Extension Division.

The Experiment Station Director reports that the state is awakening to the importance of developing its agricultural resources. All the water of the streams flowing during the crop-growing season is appropriated and used in the irrigation (in 1917) of approximately 900,000 acres of improved lands. Water-storage systems have been constructed or are proposed for the conservation of the flood waters of the streams, which will ultimately add about 500,000 acres or more to the farm acreage. Artesian water is found abundantly in many valleys, and is being utilized for irri-

**gation. In the higher valleys of northeastern and eastern Nevada, experiments in dry-farm reclamation have been successful where the proper methods have been employed. Demonstrations are being conducted by the Extension Division at Metropolis, Elko county, to establish that, under the 640-acre grazing homestead act of Congress, several million acres of sagebrush lands may be reclaimed with drought-resistant forage crops for sheep.**

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Population | 77,407 | *81,875* |
| City | 15,254 (19.7%) | *13,367* (*16.3%*) |
| Country | 62,153 (80.3%) | *68,508* (*83.7%*) |
| Number of farmers | 3,163 | *2,689* |
| White | 2,944 (93.1%) | *2,528* (*94%*) |
| Non-white | 219 (6.9%) | *161* (*6.0%*) |
| Land area, acres | 70,285,440 | |
| Acres in farms | 2,357,163 | *2,714,757* |
| Acres farm land improved | 594,741 | *752,117* |
| Average acres per farm | 745 (188 impr.) | *1,009.6* (*279* impr.) |
| Farm land artificially drained, acres | 46,252 (7.8% impr. farm land) | |
| Farm land needing drainage, acres | 59,739 (2.5% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 261 | *271* |
| 20 " 49 " | 435 | *320* |
| 50 " 99 " | 555 | *411* |
| 100 " 174 " | 611 | *555* |
| 175 " 499 " | 651 | *540* |
| Over 500 " | 650 | *592* |
| Value all farm property | $99,799,666 | *$60,399,365* |
| Per cent increase in ten years | 65.2 | *110.6* |
| Value farm land | $59,362,239 | *$35,276,599* |
| " " buildings | $6,892,975 | *$4,332,740* |
| " " implements | $3,630,927 | *$1,576,096* |
| " " livestock | $29,893,525 | *$19,213,930* |
| Av. value all property per farm | $31,546 | *$22,462* |
| " " land and buildings per acre | $28.11 | *$14.59* |
| Number farms run by owners | 2,699 (85.3%) | *2,175* (*80.8%*) |
| Number farms run by tenants | 296 (9.4%) | *333* (*12.4%*) |
| Per cent owned farms unmortgaged | 59.2 | *83* |

Per cent farms reporting automobiles 45.4; telephones 35.5

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $13,980,303 | *$5,878,425* |
| " " cereals | $1,454,350 | *$923,763* |
| Corn, acres | 547 | *585* |
| production (bu.) | 14,714 | *20,779* |
| 10-yr. av. yield per acre | 32.5 bu. | |
| Wheat, acres | 21,984 | *14,260* |
| production (bu.) | 464,151 | *396,075* |
| 10-yr. av. yield per acre | 27.3 bu. | |
| Oats, acres | 2,973 | *7,853* |
| production (bu.) | 75,000 | *334,973* |
| 10-yr. av. yield per acre | 42 bu. | |
| Rye, acres | 573 | *43* |
| production (bu.) | 4,111 | *880* |
| Barley, acres | 5,599 | *12,200* |
| production (bu.) | 148,216 | *412,149* |
| 10-yr. av. yield per acre | 40 bu. | |
| Hay and forage, acres | 353,300 | *350,538* |
| production (tons) | 548,033 | *521,918* |
| value | $10,964,159 | *$4,185,270* |
| Potatoes, white, acres | 3,639 | *4,864* |
| production (bu.) | 490,727 | *766,826* |
| 10-yr. av. yield per acre | 169 | |
| Small fruits, acres | 25 | *37* |
| production (quarts) | 21,705 | *50,287* |
| Strawberries, acres | 5 | *5* |
| production (quarts) | 5,136 | *11,189* |
| Vegetables, acres 518; value | $1,384,421 | *$661,803* |
| Apples, production (bu.) | 52,619 | *74,449* |
| Pears, production (bu.) | 4,104 | *4,083* |
| Peaches, production (bu.) | 5,868 | *3,171* |
| Plums and prunes (bu.) | 4,418 | *3,857* |
| Grapes, production (lbs.) | 371,543 | *376,205* |
| Forest products, value | $37,437 | *$42,748* |

Nurseries: acre 1 in 1 establishment; receipts $30
Greenhouses: sq. ft. under glass 14,000; receipts $5,600

**3. Livestock, 1920 and *1910***

Number farms reporting livestock 3,024; pure breds 498

| | 1920 | *1910* |
|---|---|---|
| Value all livestock on farms | $29,893,525 | *$19,213,930* |
| Horses, number | 50,486 | *68,453* |
| value | $2,808,606 | *$3,770,402* |
| Mules, number | 2,540 | *2,786* |
| value | $175,765 | *$233,800* |
| All cattle, number | 356,390 | *449,681* |
| value | $16,304,472 | *$9,766,723* |
| Beef cattle, number | 332,299 | |
| Dairy cattle, number | 24,091 | *17,084* |
| Sheep, number | 880,580 | *1,154,795* |
| value | $9,871,206 | *$5,101,328* |
| Goats, number | 1,123 | *4,849* |
| value | $8,062 | *$11,710* |
| Swine, number | 26,645 | *23,160* |
| value | $344,350 | *$151,851* |
| Poultry, number | 163,984 | *133,217* |
| value | $183,411 | *$93,668* |
| Bees, number of hives | 11,998 | *8,401* |
| Livestock products, value | $4,694,649 | *$1,998,377* |
| Value all dairy products | $963,966 | *$518,179* |
| " eggs and chickens | $585,698 | *$379,323* |
| " wool and mohair | $3,010,068 | *$1,063,873* |
| " honey and wax | $134,917 | *$37,002* |
| Milk produced (gallons) | 6,312,105 | *4,356,555* |
| Butter made (lbs.) | 266,027 | *403,885* |
| Eggs produced (dozens) | 895,487 | *862,655* |

**4. Irrigation, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Acres in irrigated projects | 1,382,036 | *1,232,142* |
| " of projects irrigable | 704,708 | *840,962* |
| " " " irrigated | 561,447 | *701,833* |
| " " irrigated land open to settlement | 139,352 | |
| Capital invested in projects | $14,754,280 | *$6,721,924* |
| Average investment, per acre | $20.94 | *$7.99* |
| Estimated final cost | $22,648,747 | *$12,188,756* |
| Average cost per acre | $16.39 | *$9.89* |
| Average cost maintenance and operation, per acre | $0.79 | *$0.97* |
| Acres of crops on irrigated land | 331,177 | |
| Value of crops on irrigated land | $12,390,593 | |
| Av. value crops on irrigated land, per acre (1919) | $37.41 | |

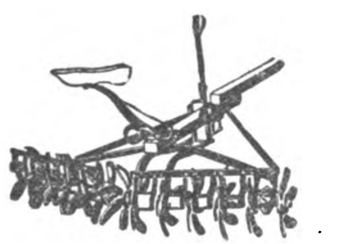


**Fig. 373. Cutaway disc harrow**


# NEW HAMPSHIRE

**NEW HAMPSHIRE** ("Granite State"), one of the New England States, lies between 42 and 46 degrees north latitude, and 70 and 73 degrees west longitude. The Connecticut River and Hall's Stream, a small tributary, form the entire western boundary, and the Salmon Falls and Piscataqua River the southeastern. The largest river is the Merrimac, draining the central part of the state and flowing south into Massachusetts before emptying into the Atlantic Ocean. The northeastern part is drained by the Androscoggin River. Area, 9,341 square miles, of which 310 square miles are water surface.

**Land surface.** A mountainous area crosses the state from northeast to southwest, nearly parallel with the western border. The height varies from 1,500 feet in the south to 4,000 feet in the north. West of this is the Connecticut River basin. The southeast part within 25 miles of the coast is mainly level, with only occasional hills. The plateau region of the White Mountains, with an average elevation of 1,600 to 1,800 feet, occupies the north central part. It is traversed by several deep, narrow valleys, and includes more than 200 peaks, the highest and best known being Mount Washington, 6,293 feet, the highest point in northeastern United States. South of the White Mountains, the general elevation is less than 600 feet. The rough upland country is dotted with many lakes of which the largest, Winnepesaukee, is famous as a summer resort and for the beauty of its scenery.

**Soils.** The rocky soils of the higher land are glacial and strong in mineral matter, but tend to be thin and, in many places, unproductive as a result of poor treatment. Through the southern part of the state, especially towards the coast, they are much lighter and even sandy. The Connecticut River valley bottom and the land along the smaller streams is of a loamy or silty nature, uniform and fertile.

**Climate.** The climate is severe but not subject to sudden changes; in the mountains it is generally considered very healthful. The different altitudes show wide differences in temperature. At Manchester, in the south central part, the range is from 21 degrees below zero to 96 above. In the north, the temperature sometimes falls to 40 degrees and more below zero. The average annual rainfall is about 50 inches. The snowfall is heavy and the winters are long. The average frost-free season is about 130 days.

**Opportunities.** Information about locations suitable for farming or gardening may be obtained from the Experiment Station at Durham.

**Products and industries.** The leading farm activity is general farming, with dairy cattle and sheep as the important livestock features, and hay (most of which is fed on the farms) as the most important crop. Fruits (with apples leading) and vegetables are grown chiefly for local consumption, especially to supply summer resorts. Small fruits, market gardening and greenhouse gardening are receiving more attention, especially in the Merrimac River Valley. Some tobacco is raised along the Connecticut, but less than in the states to the south. While Boston and the summer resorts and factory towns in the southern part of the state provide good markets for most farm products, the short growing season, rocky soil, rough hilly surface and small fields have prevented farming from attaining any great development in the state. Chief minerals are granite and mica. Main manufactures are cotton and woolen goods, boots and shoes, paper and wood pulp, lumber and timber products, wooden packing boxes, flour and leather. Leading manufacturing cities are Manchester, Portsmouth, Concord, Nashua, Dover, Berlin, Rochester, Laconia, Keene.

**Transportation.** Railroad facilities supplied by the Boston and Maine and Grand Trunk lines are sufficient to meet the needs of tour-

ists and the larger, better located farms, but there is a good deal of farm country that can reach the main lines of traffic only by means of rough, hilly, country roads. The scenery is constantly attracting automobile traffic, however, and this is naturally resulting in road improvement.

**History.** New Hampshire was first explored by Sir Martin Pring in 1603. It was included in the First Charter of Virginia of 1606, the grant given to the Plymouth Company in 1620, and in a grant of 1622 made to the Council for New England to Mason and Gorges. In 1629, Mason secured an individual claim to the territory between the Merrimac and the Piscataqua rivers, extending 60 miles inland along the course of each, and he named it New Hampshire after his native English country. In 1635, the New England Council confirmed this grant and added 10,000 acres to it. After his death, the affairs of the colony were in such a state that it was finally placed under the protection of Massachusetts, 1641. In 1675, Robert Mason, a grandson of the original proprietor, obtained a royal decree under which, in 1680, a separate Colonial government was established. After a century of dispute, the Mason claims were purchased by a land company, but boundary lines were in dispute till 1894. Early in 1775, New Hampshire declared for Independence, and was the first of the Colonies to adopt a state constitution. In 1783, it passed an ordinance freeing its slaves, and in 1788, ratified the Federal Constitution. Capital, Concord; population, 1910, 19,632.

**Agricultural organization.** College of Agriculture and Mechanic Arts and Experiment Station, *Durham*. Commissioner of Agriculture, *Concord*. Dairymen's Association, Horticultural Society, Potato Growers' Association, Sheep Breeders' Association, State Grange.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 443,083; | *430,572* |
| City | 279,761 (63.1%); | *255,099 (59.2%)* |
| Country | 163,322 (36.9%); | *175,473 (40.8%)* |
| Number of farmers | 20,523; | *27,053* |
| White | 20,509 (99.9%); | *27,038 (99.9%)* |
| Non-white | 14 (.1%); | *15 (.1%)* |
| Land area, acres | 5,779,840 | |
| Acres in farms | 2,603,806; | *3,249,458* |
| Acres farm land improved | 702,902; | *929,185* |
| Av. acres per farm | 126.8 (34 impr.); | *120 (34.3 impr.)* |
| Farm land artificially drained, acres | 11,777 (1.7% impr. farm land) | |
| Farm land needing drainage, acres | 40,783 (1.6% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 2,897; | *4,595* |
| 20 " 49 " | 3,375; | *4,509* |
| 50 " 99 " | 4,888; | *6,248* |
| 100 " 174 " | 4,986; | *6,247* |
| 175 " 499 " | 3,809; | *4,774* |
| Over 500 " | 568; | *680* |
| Value all farm property | $118,656,115; | *$103,704,196* |
| Per cent increase in ten years | 13.4; | *20.8* |
| Value farm land | $47,425,331; | *$44,519,047* |
| " " buildings | $42,570,539; | *$41,397,014* |
| Value farm implements | $9,499,322; | *$5,877,657* |
| " " livestock | $19,160,923; | *$11,910,478* |
| Av. value all property per farm | $5,782; | *$3,833* |
| " " land and buildings per acre | $34.56; | *$26.44* |
| Number farms run by owners | 18,604 (90.6%); | *24,493 (90.5%)* |
| Number farms run by tenants | 1,373 (6.7%); | *1,879 (6.9%)* |
| Per cent owned farms unmortgaged | 64.5; | *74* |
| Per cent farms reporting automobiles 23.4; telephones 49.5 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $23,509,665; | *$12,112,260* |
| " " cereals | $1,456,628; | *$879,631* |
| Corn, acres | 10,433; | *19,814* |
| production (bu.) | 482,738; | *916,263* |
| 10-yr. av. yield per acre | 44.2 bu. | |
| Wheat, acres | 1,366; | *70* |
| production (bu.) | 21,968; | *1,311* |
| Oats, acres | 14,688; | *10,860* |
| production (bu.) | 485,367; | *386,419* |
| 10-yr. av. yield per acre | 37 bu. | |
| Rye, acres | 627; | *260* |
| production (bu.) | 6,760; | *4,534* |
| Barley, acres | 887; | *848* |
| production (bu.) | 22,036; | *20,764* |
| 10-yr. av. yield per acre | 27.9 bu. | |
| Hay and forage, acres | 465,303; | *529,817* |
| production (tons) | 606,713; | *582,454* |
| value | $13,616,378; | *$7,847,148* |
| Potatoes, white, acres | 13,334; | *17,370* |
| production (bu.) | 1,341,978; | *2,360,241* |
| 10-yr. av. yield per acre | 124 bu. | |
| Buckwheat, acres | 631; | *1,052* |
| production (bu.) | 10,940; | *26,312* |
| 10-yr. av. yield per acre | 23.5 bu. | |
| Maple sugar, trees tapped | 648,761; | *792,147* |
| sugar made (lbs.) | 329,723; | *558,811* |
| syrup made (gals.) | 112,824; | *111,500* |
| Small fruits, acres | 1,071; | *618* |
| production (quarts) | 753,969; | *998,244* |
| Strawberries, acres | 366; | *310* |
| production (quarts) | 489,774; | *638,057* |
| Vegetables, acres 2,592; value | $5,228,489; | *$2,276,177* |
| Apples, production (bu.) | 1,364,001; | *1,108,424* |
| Pears, production (bu.) | 17,274; | *24,224* |
| Peaches, production (bu.) | 39,019; | *23,218* |
| Plums and prunes, (bu.) | 8,429; | *7,542* |
| Grapes, production, (lbs.) | 215,514; | *375,164* |
| Forest products, value | $5,532,115; | *$3,610,178* |
| Nurseries: acres 91 in 12 establishments; receipts $30,755 | | |
| Greenhouses: sq. ft. under glass 754,238; receipts $317,428 | | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Farms reporting livestock | 18,404; | pure breds 2,775 |
| Value all livestock on farms | $19,160,923; | *$11,910,478* |
| Horses, number | 38,194; | *46,229* |
| value | $5,218,893; | *$5,266,389* |
| Mules, number | 248; | *195* |
| value | $34,694; | *$29,681* |
| All cattle, number | 163,653; | *167,831* |
| value | $11,317,213; | *$5,240,122* |
| Beef cattle, number | 18,277; | |
| Dairy cattle, number | 145,376; | *101,278* |
| Sheep, number | 28,021; | *43,772* |
| value | $312,490; | *$192,346* |
| Goats, number | 3,574; | *495* |
| value | $23,699; | |
| Swine, number | 41,655; | *45,237* |
| value | $891,021; | *$504,174* |
| Poultry, number | 782,775; | *924,859* |
| value | $1,334,836; | *$694,121* |
| Bees, number of hives | 4,191; | *4,644* |
| Livestock products, value | $14,681,368; | *$8,573,337* |
| Value all dairy products | $10,224,888; | *$5,589,711* |
| " eggs and chickens | $4,341,810; | *$2,922,352* |
| " wool and mohair | $95,691; | *$57,651* |
| " honey and wax | $18,979; | *$13,623* |
| Milk produced (gallons) | 42,556,285; | *35,033,153* |
| Butter made (lbs.) | 3,240,368; | *5,065,188* |
| Eggs produced (dozens) | 5,005,302; | *7,469,472* |

# NEW JERSEY

**NEW JERSEY** ("Blue Hen State"), one of the North Atlantic States, lies between 38 and 42 degrees north latitude, and 73 and 76 degrees west longitude. The extreme length of the state is 160 miles, width, 70 miles, area, 8,224 square miles, 710 miles of which are water.

**Land surface.** New Jersey is very irregular in outline, greatly diversified in surface and soil, and admirably adapted for growing, somewhere within its border, almost every temperate-climate product. Southern New Jersey is in the Coastal Plain region, level or gently rolling. The highest point of the watershed is less than 400 feet, while most of the region is less than 100 feet above sea level. The slope is toward the Atlantic Ocean and the Delaware River. The coast is made up of narrow, sandy beaches, tide marshes, inlets, shallow bays and sounds. The northern part is in the Appalachian Highland, attaining a height of 1,800 feet on the northern border. Many of the higher elevations are rocky and bare, others are wooded, the intervening valleys varying from narrow chasms to broad intervales of fertile soil. It has many small and rapid streams and clear lakes. Between and merging into these two main regions is the Red Sandstone Plain extending across the state.

**Soils.** Through the center of the state, the soil is mostly a red shale or clay marl, admirably adapted for general crops and mixed farming. In the north, the soil in the valleys is alluvial and fertile, on the hills rocky and thinner, but well adapted for tree fruits and grazing. The southern part is in general sandy with heavier fertile soil along the western border, with areas of marshy land suitable for cranberries. In the pine region in the center of this section, the soil is lighter, but when cleared, well adapted for small fruits.

**Climate.** In the south, the climate is modified by the Ocean and Delaware Bay, and is very equable; zero temperatures and those above 100 degrees are rare. The average annual temperature is about 53.5 degrees, and the frost-free season about 180 days. In the north, the temperature runs lower in winter and higher in summer. The frost-free season averages about 150 days. Here the average annual rainfall is about 48 inches; in the south, it is somewhat less with the lowest on the coast from Cape May to Atlantic City. The average annual snowfall in the north ranges from 31 to 34 inches; in the south, less than 20 inches.

**Opportunities.** There is no untaken public land. Many farms, once under cultivation, are neglected or temporarily untilled, which, by the proper use of commercial fertilizers and green manures, could be improved and made fairly productive, and, in many instances, could be bought for less than the cost of the buildings. In middle and north Jersey, many thousands of acres are now untilled, and good farms may be bought at a very moderate price. The growth of the home markets, the nearness of the large consuming centers in New York and Pennsylvania, the excellent roads and fine transportation facilities, make New Jersey an attractive field for agricultural development. The State Board of Agriculture, Trenton, helps prospective settlers to find farms. Information on the quality of the soils and their value for different types of farming may be had from the Agricultural Experiment Station, New Brunswick.

**Products and industries.** Leading farm activities through the central part of the state are the production of general farm crops, corn and oats being the leading grains. Potatoes are largely grown in the south central part, and sweet potatoes farther south and west. Vegetables of all kinds for the city markets are grown in immense quantities, and fruits of every kind are raised commercially. Peaches lead in the northwest

and are also grown toward the south. Apples are grown largely in the north and in the south central part; pears, plums and grapes in the south, and small fruits in most of the state. In cranberries, New Jersey leads all other states. Gardening and flower growing under glass are important industries. Dairying and poultry are the leading livestock industries. In fisheries, New Jersey leads the Middle Atlantic States, oysters and clams forming the larger part of the product. There is considerable lumbering, largely from second growth. The leading mineral is iron ore. Main manufactures are silks (in which New Jersey surpasses all other states), felt hats, cotton and woolen goods, petroleum products, iron and steel, leather, malt liquors, meat products, electrical apparatus and supplies, chemicals, clay products, wire, rubber goods, jewelry, tobacco products, boots and shoes, glass. Leading manufacturing cities are Newark, Jersey City, Bayonne, Paterson, Perth Amboy, Camden, Trenton, Elizabeth and Passaic.

**Transportation and markets.** New Jersey excels all other states in railroad mileage in proportion to its size. The rivers and bays about the state furnish excellent facilities for local water transportation, and electric railway mileage is large. New York and Philadelphia, on either side, furnish markets for every kind of product, and are supplemented by the many cities and towns, and summer and seashore resorts within the state.

**History.** First visited by Gomez in 1524. Settlements by the Swedes along the Delaware and the Dutch in the northeast early in the seventeenth century. Hoboken was settled in 1640. In 1774, the first provincial congress of New Jersey met at New Brunswick, and a state constitution was adopted in 1776. New Jersey was the third state to ratify the Federal constitution. Trenton (population, 1910, 96,815) made permanent capital in 1790.

**Agricultural organization.** College of Agriculture and Mechanic Arts and Experiment Station, and County Demonstration Work, *New Brunswick*. State Board of Agriculture, *Trenton*. State Horticultural Society, State Poultry Association, American Cranberry Growers' Association, New Jersey Alfalfa Association, New Jersey Live Stock Breeders' Association, E. B. Voorhees Agricultural Society. The Interstate Fair is held annually at *Trenton*.

The Experiment Station Director reports that, since 1880, there has been a steady decrease in the area of tilled land in New Jersey, but a progressive increase in the value of agricultural products grown. Records show that the yields per acre are increasing and that farm practice in New Jersey is becoming more intensive. Less land is being farmed than formerly, but better methods are in vogue. General farming is becoming less prominent as time goes on. Specialized farming, on the other hand, is being emphasized. Potato production, the growing of apples, vegetables and cut flowers, and the production of market milk and eggs and poultry are occupying a constantly more important position. There has been a revival of interest in the production of meat animals, notably hogs and Milking Shorthorns. Striking progress has been made in some sections in the development of vegetable growing under overhead irrigation. Sections of central and southern New Jersey, in which farmers have become expert in the use of commercial fertilizers and green manures, have made notable progress. The potato growers of Monmouth, Mercer, Burlington, Cumberland and Salem Counties have been able to increase to a very marked extent the average yields per acre. Among the agricultural enterprises recently developed on a large scale may be mentioned the fruit orchards at Glassboro, Vineland and Bridgeton; the vegetable growing in the vicinity of Bridgeton, and the dairy development in the vicinity of Plainsboro, Wrightstown, Somerville, Montclair and elsewhere.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population......3,155,900; *2,537,167*

City.....2,474,936 (78.4%); *1,907,210 (75.2%)*

Country.....680,964 (21.6%); *629.957 (24.8%)*

Number of farmers......29,702; *33,487*

White.....29,167 (98.2%); *33,011 (98.6%)*

Non-white.......535 (1.8%); *476 (1.5%)*

Land area, acres......4,808,960

Acres in farms......2,282,585; *2,573,857*

Acres farm land improved......1,555,607; *1,803,336*

Av. acres per farm.....76.8 (52 impr.); *76.9 (53.9* impr.)

Acres artificially drained, 174,260 (11.2% impr. farm land)

Acres needing drainage......77,881 (3.4% all farm land)

Farms by size, number:

Up to 19 acres......7,222; *8,073*

20 " 49 " ......6,763; *7,607*

50 " 99 " ......7,367; *8,194*

100 " 174 " ......6,251; *7,207*

175 " 499 " ......1,950; *2,235*

Over 500 " ...... 149; *171*

Value all farm property.....$311,847,948; *$254,832,665*

Per cent increase in ten years......22.3; *34.5*

Value farm land......$142,182,498; *$124,143,167*

" " buildings.......$108,141,488; *$92,991,352*

" " implements......$25,459,205; *$13,109,507*

" " livestock.......$238,774,641; *$141,480,052*

Av. value all property per farm.........$10,499; *$7,610*

" " land and buildings per acre....$109.67; *$84.36*

Farms run by owners...21,889 (70.3%); *24,133 (72.6%)*

Farms run by tenants......6,826 (23%); *8,294 (24.8%)*

Per cent owned farms unmortgaged..........45.7; *49.7*

Per cent farms reporting automobiles 39.5; telephones 31.9

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops..........$87,484,186; *$35,648,849*

" " cereals..........$20,902,859; *$9,797,937*

Corn, acres...... 233,595; *265,441*

production (bu.)...... 8,776,107; *10,000,731*

10-yr. av. yield per acre..........39.8 bu.

Wheat, acres...... 84,897; *83,637*

production (bu.)...... 1,378,269; *1,489,233*

10-yr. av. yield per acre..........18.2 bu

Oats, acres...... 71,065; *72,130*

production (bu.)...... 1,477,319; *1,376,752*

10-yr. av. yield per acre..........31.3 bu.

Rye, acres...... 74,174; *69,032*

production (bu.)...... 1,043,916; *951,271*

| | | |
|---|---|---|
| Rye, 10-yr. av. yield per acre | 18 bu. | |
| Barley, acres | 894; | *152* |
| production (bales) | 14,613; | *3,082* |
| Hay and forage, acres | 387,642; | *401,315* |
| production (tons) | 674,479; | *569,442* |
| value | $14,017,095; | *$7,630,037* |
| Potatoes, white, acres | 82,533; | *72,991* |
| production (bu.) | 10,319,306; | *8,057,424* |
| 10-yr. av. yield per acre | 109 bu. | |
| sweet, acres | 15,427; | *22,504* |
| production (bu.) | 1,772,829; | *3,186,499* |
| 10-yr. av. yield per acre | 125 bu. | |
| Buckwheat, acres | 8,222; | *13,155* |
| production (bu.) | 110,309; | *112,548* |
| 10-yr. av. yield per acre | 19.7 bu. | |
| Small fruits, acres | 15,614; | *24,069* |
| production (quarts) | 20,289,727; | *38,822,987* |
| Strawberries, acres | 5,029; | *8,684* |
| production (quarts | 8,301,893; | *18,767,473* |
| Vegetables, acres 94,996; value | $40,669,147; | *$14,073,467* |
| Apples, production (bu.) | 1,666,400; | *1,406,778* |
| Pears, production (bu.) | 401,706; | *462,290* |
| Peaches, production (bu.) | 1,653,223; | *441,440* |
| Plums and prunes (bu.) | 8,526; | *9,594* |
| Grapes, production (lbs.) | 4,357,396; | *6,501,221* |
| Forest products, value | $1,219,810; | *$758,515* |
| Nurseries: acres 3,337 in 101 establishments; receipts | $1,048,919 | |
| Greenhouses: sq. ft. under glass 8,725,939; receipts | $5,064,684 | |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Number farms reporting livestock | 26,783; | pure breds 2,346 |
| Value all livestock on farms | $36,064,757; | *$24,588,639* |
| Horses, number | 72,621; | *88,922* |
| value | $9,653,169; | *$12,012,512* |
| Mules, number | 5,705; | *4,041* |
| value | $903,374; | *$621,774* |
| All cattle, number | 179,459; | *222,999* |
| value | $18,347,004; | *$8,393,117* |
| Beef cattle, number | 6,766; | |
| Dairy cattle, number | 172,693; | *154,418* |
| Sheep, number | 10,471; | *30,683* |
| value | $145,785; | *$161,138* |
| Goats, number | 642; | *574* |
| value | $7,713; | |
| Swine, number | 139,222; | *147,005* |
| value | $2,602,897; | *$1,127,040* |
| Poultry, number | 2,665,662; | *2,597,448* |
| value | $4,324,584; | *$2,221,610* |
| Bees, number of hives | 12,451; | *10,484* |
| Livestock products, value | $31,482,945; | *$17,951,089* |
| Value all dairy products | $19,198,718; | *$10,156,600* |
| " eggs and chickens | $12,200,716; | *$7,749,034* |
| " wool and mohair | $32,071; | *$22,538* |
| " honey and wax | $51,440; | *$22,917* |
| Milk produced (gallons) | 70,490,729; | *67,698,219* |
| Butter made (lbs.) | 1,600,789; | *3,622,411* |
| Eggs produced (dozens) | 13,280,104; | *14,590,530* |

# NEW MEXICO

**NEW MEXICO,** one of the southwestern states, lies between 31 and 37 degrees north latitude, and 103 and 110 degrees west longitude. Area, 122,634 square miles, of which 131 are water.

Land surface. This is everywhere more than 3,000 feet above sea level, and the highest elevations (in the Rocky Mountains) reach 12,000 to 14,000 feet. Practically the entire western half of the state is mountainous, the Continental Divide, the Rockies and many lesser ranges traversing this region in all directions. The Rockies also occupy a good part of the northern half of the eastern part of the state, although they rapidly run into the Great Plains (3,000 to 3,500 feet above the sea) well inside the eastern border. The southeastern quarter is taken up by the level, arid Staked Plains which continue into Texas. In parts of the mountainous country, however, are extensive, elevated plateaus. The Rio Grande and Pecos Rivers flow entirely across the state from north to south, their valleys being narrow at the north but gradually widening to form broad stretches of arable land. The northeastern part is drained by the Canadian and Cimarron, the northwestern by the San Juan and Chuska Rivers tributary to the Colorado, the southwestern by the Gila and San Francisco.

Soils. These are mostly light and sandy on the elevated plains, some of them affording pasturage, and larger areas being devoted to dry-farming. In the river valleys generally, the soil is fertile and capable of producing abundant crops, but most of it needs irrigation, which is being supplied on considerable areas.

Climate. This is dry, moderately cool and healthful in much of the state. Temperatures vary according to latitude and altitude, but through the southern part, weather condi-

tions are said by the United States Weather Bureau to be more uniform than in any other part of the United States with a few exceptions. "Great extremes of temperature are uncommon, the air is dry and healthful under nearly all conditions, and the altitude is such as to give the best tonic effect to the human system." In the less elevated districts to the south, frosts are rare, and sunshine is abundant. Even in the hottest weather the nights are comfortable. In spring and early summer, high winds and dust storms occur, but destructive storms are rare, mostly in the form of occasional cloudbursts in the mountains. The average annual rainfall varies from 10 inches or less in the south to 20 inches in the north, and even 30 inches or more in the mountains. The frost-free season varies from about 270 days in the south to 160 to 170 days in the north.

**Opportunities.** Land under irrigation projects is available for settlement. Land offices are located at Santa Fe, Tucumcari, Las Cruces, Fort Sumner, Clayton and Las Vegas, from any of which definite information may be obtained. There are two extensive irrigation projects, besides smaller ones. One, known as the Elephant Butte Project and located in the Rio Grande Valley about 100 miles from the southern boundary, is one of the largest projects ever undertaken by the U. S. Reclamation Service, and furnishes water for an immense acreage in New Mexico, Texas and Mexico. The stored water forms the largest artificial lake in the world, extending back fully 40 miles. The Pecos Valley Project is not so large in extent, but stores sufficient water to irrigate considerable land.

**Products and industries.** Leading farm activities are the raising of cattle, horses and sheep, with hay and forage and corn on the irrigated areas. Other grains, especially drought-resistant types, are raised to some extent, and fruits are being increasingly grown, apples leading. A larger part of New Mexico's agricultural area is devoted to dry-farming than to irrigated farming. The area in the dry-farming districts is constantly increasing. Lumbering is carried on to some extent, as there are extensive forests of yellow pine, spruce and cedar in the mountains, and cottonwood, sycamore and oak in the river valleys. The wooded area is estimated at 22,000 square miles, and there are a dozen National forest reserves comprising about 11,000,000 acres. The leading mineral is coal, with some gold, silver, copper and zinc. Manufacturing is still in its infancy.

**Transportation and markets.** The leading railroad systems are the transcontinental lines, or follow the valleys of the larger rivers. The chief markets are principally the cities and mining towns in or near the state.

**History.** The Pueblo Indians and the cliff dwellers were the original inhabitants of New Mexico, and the earliest explorers were the Spaniards. In 1528, Narvaez started on a disastrous exploring expedition. Coronado made an expedition in 1540. Santa Fe, the earliest settlement, was founded early in the seventeenth century. The region became a province of Mexico in 1821, and a possession of the United States at the close of the Mexican war in 1848. Arizona Territory was organized in 1863, after which statehood was a subject of debate in Congress until 1910, when an act was passed admitting Arizona and New Mexico as separate states. Capital, Santa Fe; population, 1910, 5,072.

**Agricultural organization.** College of Agriculture and Mechanic Arts, and Experiment Station, *State College*. There is no State Board or Commissioner of Agriculture. The New Mexico Wool Growers' Association, and the New Mexico Cattle and Horse Growers' Association are statewide organizations that are doing much for the advancement of agriculture. The State Fair is held at *Albuquerque*, and a district fair under the same management at *Roswell*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 360,350; | *327,301* |
| City | 64,960 (18%); | *46,571 (14.2%)* |
| Country | 295,390 (82%); | *280,730 (85.8%)* |
| Number of farmers | 29,844; | *35,676* |
| White | 27,969 (93.7%); | *33,528 (94%)* |
| Non-white | 1,875 (6.3%); | *2,148 (6.%)* |
| Land area, acres | 78,401,920 | |
| Acres in farms | 24,409,633; | *11,270,021* |
| Acres farm land improved | 1,717,224; | *1,467,191* |
| Average acres per farm | 817 (57 impr.); | *315.9* (*41* impr.) |
| Farm land artificially drained | 47,311 (2.8% impr. farm land) | |
| Farm land needing drainage | 49,102 (.7% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 6,789; | *6,885* |
| 20 " 49 " | 3,095; | *2,812* |
| 50 " 99 " | 2,008; | *1,820* |
| 100 " 174 " | 4,929; | *15,363* |
| 175 " 499 " | 7,015; | *7,388* |
| Over 500 " | 6,008; | *1,408* |
| Value all farm property | $325,185,999; | *$159,447,990* |
| Per cent increase in ten years | 103.8; | *196.6* |
| Value farm land | $196,341,050; | *$98,806,497* |
| " " buildings | $25,473,162; | *$13,024,502* |
| " " implements | $9,745,369; | *$4,122,312* |
| " " livestock | $93,626,418; | *$43,494,679* |
| Av. value all property per farm | $10,896; | *$4,469* |
| " " land and buildings per acre | $9.09; | *$9.92* |
| Number farms run by owners | 25,756 (86.3%); | *33,398 (93.6%)* |
| Number farms run by tenants | 3,655 (12.2%); | *1,957 (5.5%)* |
| Per cent owned farms unmortgaged | 64.6; | *94* |
| Per cent farms reporting automobiles 18.6; telephones 11.3 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $40,619,634; | *$8,619,802* |
| " " cereals | $18,220,404; | *$2,382,996* |
| Corn, acres | 227,167; | *85,999* |
| production (bu.) | 4,737,182; | *1,164,970* |
| 10-yr. av. yield per acre | 24.2 bu. | |
| Wheat, acres | 135,185; | *32,341* |
| production (bu.) | 2,437,213; | *499,799* |
| 10-yr. av. yield per acre | 19.8 bu. | |
| Oats, acres | 40,029; | *33,707* |
| production (bu.) | 1,085,311; | *720,560* |
| 10-yr. av. yield per acre | 33.4 bu. | |
| Rye, acres | 3,751; | *257* |
| production (bu.) | 53,797; | *2,913* |

| | | |
|---|---|---|
| Cotton, acres | 10,666; | *790* |
| production (bales) | 5,399; | *206* |
| Hay and forage, acres | 436,547; | *368,409* |
| production (tons) | 693,807; | *431,053* |
| value | $12,852,751; | *$4,493,918* |
| Potatoes, white, acres | 3,070; | *6,230* |
| production (bu.) | 110,740; | *295,255* |
| 10-yr. av. yield per acre | | 91 bu. |
| sweet, acres | 605; | *211* |
| production (bu.) | 67,987; | *13,831* |
| 10-yr. av. yield per acre | | 139 bu. |
| Peanuts, acres | 197; | *126* |
| production (bu.) | 2,997; | *1,375* |
| Barley, acres | 8,976; | *2,131* |
| production (bu.) | 194,059; | *43,490* |
| 10-yr. av. yield per acre | | 30.7 bu. |
| Buckwheat, acres | 202; | *7* |
| production (bu.) | 2,150; | *102* |
| Small fruits, acres | 120; | *66* |
| production (quarts) | 53,750; | *76,532* |
| Strawberries, acres | 28; | *20* |
| production (quarts) | 14,363; | *35,634* |
| Vegetables, acres 4,071; value | $1,684,129; | *$820,497* |
| Apples, production (bu.) | 939,102; | *417,143* |
| Pears, production (bu.) | 65,452; | *29,435* |
| Peaches, production (bu.) | 198,346; | *32,533* |
| Plums and prunes (bu.) | 30,047; | *15,528* |
| Grapes, production (lbs.) | 1,003,356; | *425,415* |
| Forest products, value | $326,830; | *$253,822* |
| Nurseries: acres 22 in 8 establishments; receipts | | $2,300 |
| Greenhouses: sq. ft. under glass 158,703; receipts | | $76,178 |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Number farms reporting livestock | 28,532; | purebreds 2,331 |
| Value all livestock on farms | $93,626,418; | *$43,494,679* |
| Horses, number | 186,686; | *179,525* |
| value | $9,696,377; | *$7,868,314* |
| Mules, number | 20,369; | *14,932* |
| value | $1,874,836; | *$1,463,014* |
| All cattle, number | 1,300,335; | *1,081,663* |
| value | $63,101,300; | *$20,409,965* |
| Beef cattle, number | 1,237,541; | |
| Dairy cattle, number | 62,794; | |
| Sheep, number | 1,640,475; | *3,346,984* |
| value | $15,413,670; | *$12,072,037* |
| Goats, number | 226,862; | *412,050* |
| value | $1,091,076; | *930,702* |
| Swine, number | 87,906; | *45,409* |
| value | $7,802,084; | *$275,851* |
| Poultry, number | 739,782; | *531,625* |
| value | $2,924,006; | *$256,466* |
| Bees, number of hives | 15,733; | *10,052* |
| Livestock products, value | $8,447,826; | *$5,045,808* |
| Value all dairy products | $2,134,987; | *$726,692* |
| " eggs and chickens | $2,102,831; | *$1,051,348* |
| " wool and mohair | $4,088,528; | *$3,228,129* |
| " honey and wax | $121,480; | *$39,639* |
| Milk produced (gallons) | 12,737,649; | *6,815,942* |
| Butter made (lbs.) | 1,404,138; | *1,477,617* |
| Eggs produced (dozens) | 3,062,790; | *2,961,352* |

**4. Irrigation, 1920 and *1910***

| | | |
|---|---|---|
| Acres in irrigated projects | 961,879; | *1,102,297* |
| " of projects irrigable | 696,119; | *644,970* |
| " " " irrigated | 538,377; | *461,718* |
| " " irrigated land open to settlement | | 66,479 |
| Capital invested in projects | $18,210,412; | *$9,154,897* |
| Average investment, per acre | $26.16; | *$14.19* |
| Estimated final cost | $20,440,646; | *$11,640,091* |
| Average cost per acre | $21.25; | *$10.56* |
| " " maintenance and operation, per acre | $2.41; | *$1.36* |
| Acres of crops on irrigated land | | 233,893 |
| Value of crops on irrigated land | | $11,400,144 |
| Av. value crops on irrigated land, per acre (1919) | | $48.77 |

# NEW YORK

**NEW YORK** ("Empire State"), one of the North Atlantic States, lies between 40 and 45 degrees north latitude, and 71 and 80 degrees west longitude. It is roughly three-cornered in shape, its extreme length, east and west, being 420 miles; its extreme breadth, 310 miles; and its area, 49,024 square miles, 1,570 of which are water.

Land surface. For the most part, the state consists of uplands with a gently rolling to rough and hilly surface, but the eastern part, for perhaps 50 miles back from the border, is largely mountainous. The ridges are part of the Appalachian system, and represent some of the oldest parts, and originally the highest lands, of the continent. At present, they range from 2,200 to 5,350 feet above sea level. The rest of the state forms, in the main, an elevated plateau, cut by rivers and, in the center of the state, by a group of long, narrow lakes, the Finger Lakes. To the north and west, this land slopes to Lake Ontario and the St. Lawrence River. To the south, it forms a gradual decline that crosses the border into Pennsylvania. The Mohawk River, draining a rich valley running through the center of

the state, runs into the Hudson which passes south almost along the eastern border, first between sloping banks, but lower down between steep, rocky cliffs. The Oswego River, running into Lake Ontario, drains the lakes of central New York, and the Genesee a large area in the west. Extending out from the southeast corner, is Long Island about 100 miles long and not over 15 miles wide. This consists of a hilly northern half, with elevations reaching 150 feet, and a smooth, prairie-like southern half sloping very gradually to the ocean. The state, therefore, exhibits a great variety of natural conditions in all respects.

Soils. These are largely of glacial origin. In the mountain region, they are very rocky, difficult of cultivation, generally productive, but better suited to dairying through the east and north, interspersed with general farming. In the central and western part, they are largely clay or limestone loams with very fertile alluvial soils in the valleys. Long Island is largely sandy, light along the southern border, heavier farther inland, but mostly susceptible of high cultivation. The extensive southern plateau of the western part of the state is of a stiff, poorly-drained character which needs a good deal of treatment before it can be made easily and profitably productive.

Climate. This varies widely according to altitude and nearness to the seashore in the east, and lakes in the west. The average annual temperature of western New York is about 46 degrees, being highest near Lake Ontario and lower farther south. The "Chautauqua Grape Belt," which extends for about 60 miles along the south shore of Lake Erie, is said to have the most temperate climate of any part of the state, except that along the Atlantic Coast. Highest and lowest recorded temperatures are 102 degrees, and 38 degrees below zero, the latter being unusual. The frost-free season averages about 140 days, being longest near the lakes. Average annual rainfall is about 45 inches, highest in the southern counties. In the central and eastern parts, the temperature averages somewhat lower, the frost-free season shorter, and the average rainfall less. On Long Island, zero temperatures and those above 100 degrees are very infrequent. The seasonal rainfall is ample, and the average frost-free season is 211 days.

Opportunities. While much of the land is held, and often farmed, at high valuations, there remain many acres of so-called "abandoned" farms which, carefully chosen and managed, can be made into profitable and comfortable homes. As generally found through the East, drainage and similar improvements are usually individual matters, though there are some drainage projects in the central and western parts of the state, which bring under cultivation considerable areas of rich alluvial soil. Information about farms for sale may be obtained from the Department of Agriculture, Albany. Increased raising of livestock offers a real New York opportunity.

Products and industries. New York, though largely farmed along general lines, is primarily a state of many special crops grown in definite localities. Thus we find medium-sized general hay and dairy farms all over it, in addition to several well-defined belts. Fruit is the main crop along the shores of Lakes Ontario and Erie, and over the hills lying back from the Hudson River. The Erie section is famed for its grapes as are also the shores of the lakes in the center of the state; peaches and apples are more important in the other two. Profitable orchards are found scattered through the center of the state, and especially around Rochester, which is also the center of an important nursery industry. Dairying is the main issue through the Mohawk Valley and in several northern and southeastern counties. South of the fruit belt in the west is an extensive bean-growing district. Numerous canneries in western New York stimulate the raising of many special vegetable crops on a large scale, and market gardening is highly developed around the larger cities, especially on the western half of Long Island, of which the eastern part is more given to the raising of potatoes, cabbage and cauliflower. Of the general crops, oats, hay, potatoes, buckwheat, corn (largely for silage) and rye are most important. The alfalfa acreage is steadily increasing. Dairy cattle are the most important livestock, there being many herds of excellent purebreds. Horses are raised to a considerable extent, but less than formerly, which is true also of sheep. Hogs and poultry are found on most farms, but are not restricted to particular belts or localities. Minerals are largely building stone, salt, iron ore. Fisheries are important, oysters being of greatest value. Main manufactures are clothing; machine-shop products; textile goods; sugar refining; malt liquors; flour and cereal products; tobacco products; chemicals; meat products; hosiery and knit goods; wood-working products; petroleum refining; paper and wood pulp; cheese, butter and condensed milk; boots and shoes. Leading manufacturing cities are New York, Buffalo, Rochester, Syracuse, Albany, Troy, Gloversville, Binghamton, Cohoes and Yonkers.

Transportation and markets. New York is well covered with railroads and many important electric lines. Water communication with the whole world is possible by way of canals, rivers, the lakes or the sea. The Barge Canal connects the Hudson River with Lake Erie at Buffalo. Via the Great Lakes, Canada and the west are reached. The Hudson River is navigable for large boats to Troy, 150 miles. New York is the leading market, the metropolis of the United States, and the

second largest city in the world. Other important markets are Buffalo, Rochester and Syracuse.

**History.** Though numerous explorers had previously visited the mouth of the Hudson, Henry Hudson "discovered" the river which bears his name in 1609, and established the Dutch claim to ownership. Just previous, Champlain had come down from the north and discovered the lake afterward named for him. The Dutch established trading posts at Albany in 1614, on Manhattan Island in 1615, and on the Delaware River in 1623. In 1626, Governor Peter Minuit bought Manhattan Island from the Indians for goods valued at $24. Dutch rule ended, and New Netherlands became New York in 1664. A Colonial Congress met in 1690, the Albany Convention in 1764, the Stamp Act Congress in New York 2 years later. In 1776, the British fleet took possession of New York. The state was the eleventh to join the Union. Congress met in New York City from 1785 to 1790 and here Washington was inaugurated, 1789. First convention for organization of state government met at White Plains, 1776, and first constitution adopted the following year.

**Agricultural organization.** State College of Agriculture and Experiment Station, *Ithaca*; State Experiment Station, *Geneva*; State Schools of Agriculture, *Farmingdale*, *Morrisville*, *Alfred*, *Canton*, *Cobleskill* and *Delhi*. Coöperative Demonstration Work, *Ithaca*, Department of Agriculture and Farmers' Institute Bureau, *Albany*. There are also a Dairymen's Association, Breeders' Association, Fruit Growers' Association; Western New York Fruit Growers' Association, Horticultural Society, Nurserymen's Association, Vegetable Growers' Association. The State Fair Commission holds an annual fair at *Syracuse*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 10,385,227; | *9,113,614* |
| City | 8,589,844 (82.7%); | *7,185,494 (78.8%)* |
| Country | 1,795,383 (17.3%); | *1,928,120 (21.2%)* |
| Number of farmers | 193,195; | *215,597* |
| White | 192,645 (99.7%); | *214,658 (99.6%)* |
| Non-white | 550 (.3%); | *939 (.4%)* |
| Land area, acres | 30,498,560 | |
| Acres in farms | 20,632,803; | *22,030,367* |
| Acres farm land improved | 13,158,781; | *14,844,039* |
| Av. acres per farm | 106.7 (68.1 impr.); | *102 (68.8 impr.)* |
| Acres artificially drained | 1,180,423 (9% impr. farm land) | |
| Acres needing drainage | 720,183 (3.5% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 26,540; | *34,188* |
| 20 " 49 " | 27,267; | *31,047* |
| 50 " 99 " | 50,784; | *56,821* |
| 100 " 174 " | 56,929; | *61,031* |
| 175 " 499 " | 30,461; | *31,163* |
| Over 500 " | 1,214; | *1,347* |
| Value all farm porperty | $1,908,483,201; | *$1,451,481,495* |
| Per cent increase in ten years | 12.0; | *35.7* |
| Value farm land | $793,335,558; | *$707,747,828* |
| " " buildings | $631,726,182; | *$476,998,001* |
| Value farm implements | $169,866,766; | *$83,644,822* |
| " " livestock | $313,554,695; | *$183,090,844* |
| Av. value all property per farm | $9,879; | *$6,732* |
| " " land and buildings per acre | $69.07; | *$53.78* |
| Farms run by owners | 151,717 (78.5%); | *166,674 (76.8%)* |
| Farms run by tenants | 37,102 (19.2%); | *44,872 (20.8%)* |
| Per cent owned farms unmortgaged | 49.8; | *55.9* |
| Per cent farms reporting automobiles 35.2; telephones 47.6 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $417,046,864; | *$190,002,699* |
| " " cereals | $82,524,839; | *$43,099,988* |
| Corn, acres | 320,325; | *512,442* |
| production (bu.) | 14,109,202; | *18,115,634* |
| 10-yr. av. yield per acre | 36.8 bu. | |
| Wheat, acres | 463,461; | *289,130* |
| production (bu.) | 9,136,268; | *6,664,121* |
| 10-yr. av. yield per acre | 20.6 bu. | |
| Oats, acres | 937,553; | *1,302,508* |
| production (bu.) | 21,595,461; | *34,795,277* |
| 10-yr. av. yield per acre | 33.2 bu. | |
| Rye, acres | 115,661; | *130,540* |
| production (bu.) | 1,520,552; | *2,010,601* |
| 10-yr. av. yield per acre | 17.4 bu. | |
| Barley, acres | 116,109; | *79,956* |
| production (bu.) | 2,273,011; | *1,922,868* |
| 10-yr. av. yield per acre | 27.2 bu. | |
| Hay and forage, acres | 5,502,943; | *5,043,373* |
| production (tons) | 9,728,317; | *7,055,429* |
| value | $169,494,524; | *$77,373,333* |
| Potatoes, white, acres | 310,403; | *394,319* |
| production (bu.) | 32,470,847; | *48,597,701* |
| 10-yr. av. yield per acre | 96 bu. | |
| Sweet, acres | 16; | *113* |
| production (bu.) | 1,498; | *10,821* |
| Tobacco, acres | 2,613; | *4,109* |
| production (lbs.) | 3,353,954; | *5,345,035* |
| 10-yr. av. yield per acre | 1,245 lbs. | |
| Maple sugar, trees tapped | 4,826,924; | *4,948,784* |
| sugar made (lbs.) | 2,012,932; | *3,160,300* |
| syrup made (gals.) | 1,080,505; | *993,242* |
| Small fruits, acres | 20,412; | *22,496* |
| production (quarts) | 25,713,901; | *37,857,829* |
| Strawberries, acres | 4,872; | *6,382* |
| production (quarts) | 8,579,563; | *15,945,863* |
| Vegetables, acres 132,042; | | |
| value | $104,070,460; | *$36,309,544* |
| Apples, production (bu.) | 14,350,317; | *25,409,324* |
| Pears, production (bu.) | 1,830,237; | *1,343,089* |
| Peaches, production (bu.) | 1,262,480; | *1,736,483* |
| Plums and prunes (bu.) | 244,294; | *553,522* |
| Grapes, production (lbs.) | 152,482,698; | *253,006,361* |
| Forest products, value | $19,311,211; | *$10,365,651* |
| Nurseries: acres 5,288 in 359 establishments | | |
| receipts | $2,310,253 | |
| Greenhouses: sq. ft. under glass 18,289,628; | | |
| receipts | $8,689,325 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 180,841; | pure breds 28,566 |
| Value all livestock on farms | $313,554,695; | *$183,090,844* |
| Horses, number | 536,171; | *591,008* |
| value | $77,762,412; | *$80,043,302* |
| Mules, number | 7,323; | *4,052* |
| value | $1,195,696; | *$650,497* |
| All cattle, number | 2,144,244; | *2,423,003* |
| value | $198,826,728; | *$83,062,242* |
| Beef cattle, number | 63,170; | |
| Dairy cattle, number | 2,081,074; | *1,509,594* |
| Sheep, number | 578,726; | *930,300* |
| value | 17,699,791; | *$4,839,651* |
| Goats, number | 2,580; | *3,475* |
| value | $29,797; | *$21,432* |
| Swine, number | 600,560; | *666,179* |
| value | $11,691,713; | *$5,905,272* |
| Poultry, number | 10,759,268; | *10,678,838* |
| value | $15,348,600; | *$7,879,386* |
| Bees, number of hives | 127,858; | *156,360* |
| Livestock products, value | $225,465,739; | *$104,867,285* |
| Value all dairy products | $179,695,810; | *$77,807,161* |
| " eggs and chickens | $42,841,499; | *$25,504,894* |
| " wool and mohair | $1,977,598; | *$1,165,588* |
| " honey and wax | $950,832; | *$389,642* |
| Milk produced (gal.) | 756,045,942; | *597,363,198* |
| Butter made (lbs.) | 24,727,662; | *23,461,702* |
| Eggs produced (dozens) | 62,175,162; | *71,191,449* |


# NORTH CAROLINA

**NORTH CAROLINA** ("Old North State"), one of the cotton states and a South Atlantic State, lies between 33 and 37 degrees north latitude, and 75 and 85 degrees west longitude. Its eastern and southeastern boundary is the Atlantic Ocean. Area, 52,425 square miles, of which 3,686 are water surface.

**Land surface.** The Coastal Plain rises gradually from sea level to an elevation of about 500 feet. Swamps and shallow lakes and lagoons are found along the coast. Next is the Piedmont Plateau, about 300 miles broad, gently rolling at first, becoming more uneven towards the mountains. Beyond this is the mountainous region containing the highest mountains east of the Mississippi, Mt. Mitchell, 6,710 feet, and more than 40 peaks of 6,000 feet or more. Its average elevation is about 4,000 feet. Numerous broad rivers including the Chonan, Roanoke, Pamlico, Neuse and Cape Fear, are navigable to the beginning of the Plateau where they become much narrower. On the west, are the Little Tennessee, Big Pigeon and French Broad Rivers, flowing into the Tennessee.

**Soils.** In the Coastal region, the upland soil is mostly a sandy loam underlaid with clay, and with much organic matter. Along the coast it is sandy and swampy. In the Piedmont region, is deep clay mixed with sand. In the mountain region, both valleys and slopes are fertile, and well adapted to all temperate climate products.

**Climate.** This varies from subtropical in the southeast to temperate in the northwest. The average annual temperature varies from 64 degrees in the southeast to 48 degrees in the northwest, the change being gradual. The frost-free season in the northwest averages about 180 days; in the southeast, about 200 days. The average annual rainfall varies from about 60 inches on the coast to about 54 inches in the northwest. Because of moisture-laden winds striking the south slope of the mountains, one station near the Georgia line reports an annual average of 82.6 inches, a greater amount than is received by any other station in the United States except on the North Pacific Coast. Snowfall is slight except in the mountains. The state lies mostly outside the great storm tracks, though tropical storms sometimes hit the coast.

**Opportunities.** Because of the wide variation in climate, elevation and soil, and the abundant rainfall, the state affords abundant opportunities for every branch of agriculture and horticulture. Some of these have been developed to a considerable extent while others are in their infancy. Information as to land and locations may be obtained from the Agricultural Experiment Station, or the Commissioner of Agriculture, both at Raleigh.

**Products and industries.** Leading farm activities are the production of corn, oats, cotton, peanuts, tobacco, hay, potatoes, sweet potatoes and yams, with sugar cane and rice in lesser amounts in the southern part. Livestock is not extensively raised, although dairying and swine production are increasing in importance in connection with the widespread campaign for more diversified agriculture. Lumbering is extensive, yet there are said to be still more than 30,000 square miles of untouched timber land. Fisheries are valuable, leading products being shad and oysters. In the mountain section, apples and grapes flourish, and on the eastern slopes, grapes and peaches. Cranberries grow wild, and all of the temperate-climate fruits do well. Trucking is carried on extensively along the coast, immense quantities of produce being shipped to northern cities to supply the early season demands. Great quantities of bulbs and flowers are grown for shipment to northern cities. North Carolina is the first among eastern states in the production of gold. Iron and copper are also found, but the state's most important mineral is mica, of which it is the chief source for the United States. Main manufactures in order of value of product are

cotton goods, tobacco products, lumber and timber products, cottonseed oil and cake, flour and grist-mill products, furniture and refrigerators, fertilizers, leather, hosiery and knit goods, carriages and railroad-shop products, foundry and machine-shop products, men's clothing, brick and tile. Chief manufacturing cities are Charlotte, Wilmington, Raleigh, Durham.

**Transportation and markets.** The railroad facilities over most of the state are excellent. Public roads, especially in the more level sections, are rapidly being extended and improved. In many parts of the state are excellent highways. Chief ports are Wilmington, Newbern, Washington and Elizabeth City.

**History.** The first exploring expedition was sent by Sir Walter Raleigh in 1584, and was followed by others in 1585 and 1587. These founded Roanoke where was born Virginia Dare, believed to be the first child born of English parents in America. In 1653, the first permanent settlement was made at Albemarle by a company of Virginia dissenters. The territory was divided into North Carolina and South Carolina about 1665. North Carolina was a leader in the American Revolution. Its state constitution was ratified in 1786, and in 1789 it ratified the United States Constitution. Before the Civil War, North Carolina opposed secession, but a secession ordinance was adopted, May 20, 1861. During the war, the state lost more soldiers than any other Confederate state. Capital, Raleigh, population, 1910, 19,218.

**Agricultural organization.** College of Agriculture and Mechanic Arts, *West Raleigh*, Experiment stations at both *Raleigh* and *West Raleigh*. A. & T. College for Negroes, *Greensboro*. State Fair held at *Raleigh*. State Fair Association, Farmers' Union, Horticultural Association, United Fruit Growers of Western North Carolina, Good Roads Association.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Population | 2,559,123 | *2,206,287* |
| City | 290,370 (19.2%) | *318,474 (14.4%)* |
| Country | 2,068,753 (80.8%) | *1,887,813 (85.6%)* |
| Number of farmers | 269,763 | *253,725* |
| White | 193,473 (43.4%) | *188,069 (45.1%)* |
| Non-white | 65,656 (28.3%) | *74,849 (25.9%)* |
| Land area, acres | 31,193,600 | |
| Acres in farms | 20,021,736 | *22,439,129* |
| Acres farm land improved | 8,198,409 | *8,813,056* |
| Average acres per farm | 72.2 (30.3 impr.) | *88.4 (34.7 impr.)* |
| Farm land artificially drained, acres | 1,066,933 (13% impr. farm land) | |
| Farm land needing drainage, acres | 1,925,343 (9.6% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 51,336 | *43,224* |
| 20 " 49 " | 87,239 | *75,629* |
| 50 " 99 " | 68,903 | *62,157* |
| 100 " 174 " | 41,082 | *43,987* |
| 175 " 499 " | 19,094 | *25,254* |
| Over 500 " | 2,109 | *3,474* |
| Value all farm property | $1,250,166,995 | *$537,716,210* |
| Per cent increase in ten years | 132.4 | *130* |
| Value farm land | $857,815,016 | *$343,164,945* |
| " " buildings | $218,557,944 | *$113,459,662* |
| " " implements | $54,621,363 | *$18,441,619* |
| " " livestock | $119,152,672 | *$62,649,984* |
| Av. value all property per farm | $4,634 | *$2,119* |
| " " land and buildings per acre | $53.76 | *$20.35* |
| Number farms run by owners | 151,376 (56.1%) | *145,320 (57.2%)* |
| Number farms run by tenants | 117,459 (43.5%) | *107,287 (42.3%)* |
| Per cent owned farms unmortgaged | 68. | *80.5* |
| Per cent farms reporting automobiles 15.5; telephones 12.2 | | |

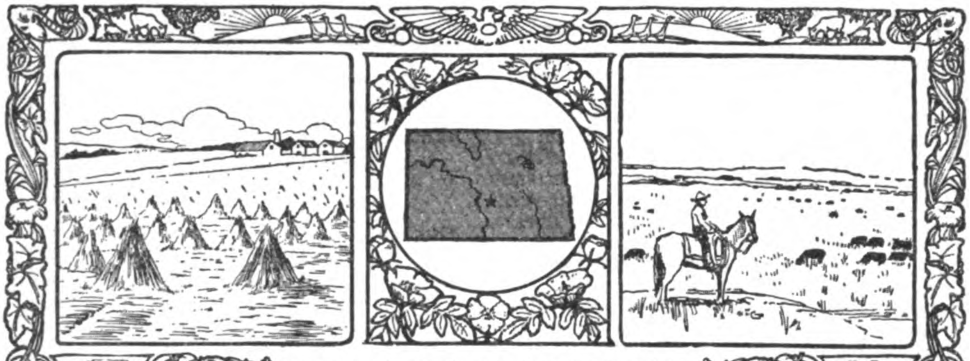
### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $503,229,313 | *$131,071,959* |
| " " cereals | $94,616,625 | *$37,858,797* |
| Corn, acres | 2,311,462 | *2,459,547* |
| production (bu.) | 40,998,317 | *34,063,531* |
| 10-yr. av. yield per acre | 19.9 bu. | |
| Wheat, acres | 620,659 | *501,912* |
| production (bu.) | 4,744,528 | *3,827,145* |
| 10-yr. av. yield per acre | 10.1 bu. | |
| Oats, acres | 125,885 | *228,120* |
| production (bu.) | 1,671,308 | *2,782,508* |
| 10-yr. av. yield per acre | 18.4 bu. | |
| Rye, acres | 67,871 | *48,685* |
| production (bu.) | 390,123 | *280,431* |
| 10-yr. av. yield per acre | 9.8 bu. | |
| Cotton, acres | 1,373,701 | *1,274,404* |
| production (bales) | 858,406 | *665,132* |
| 10-yr. av. yield per acre | 258 lbs. | |
| Hay and forage, acres | 992,374 | *375,795* |
| production (tons) | 688,843 | *369,332* |
| value | $18,966,611 | *$4,798,823* |
| Potatoes, white, acres | 35,797 | *31,990* |
| production (bu.) | 2,853,797 | *2,372,260* |
| 10-yr. av. yield per acre | 80 bu. | |
| Sweet, acres | 74,678 | *84,740* |
| production (bu.) | 7,959,786 | *8,493,283* |
| 10-yr. av. yield per acre | 98 bu. | |
| Peanuts, acres | 125,766 | *195,134* |
| production (bu.) | 5,854,689 | *5,980,919* |
| Tobacco, acres | 459,011 | *221,890* |
| production (lbs.) | 280,163,432 | *138,813,163* |
| 10-yr. av. yield per acre | 643 lbs. | |
| Sorghum, acres | 30,624 | *20,662* |
| production (tons) | 100,463 | *84,753* |
| Buckwheat, acres | 5,539 | *11,606* |
| production (bu.) | 63,478 | *144,186* |
| 10-yr. av. yield per acre | 19 bu. | |
| Small fruits, acres | 4,099 | *6,701* |
| production (quarts) | 4,776,710 | *12,827,427* |
| Strawberries, acres | 2,186 | *5,420* |
| production (quarts) | 3,807,598 | *10,313,361* |
| Vegetables, acres 14,710; value | $35,784,948 | *$12,585,018* |
| Apples, production (bu.) | 1,938,038 | *4,775,693* |
| Pears, production (bu.) | 111,548 | *84,019* |
| Peaches, production (bu.) | 479,218 | *1,344,410* |
| Plums and prunes (bu.) | 37,415 | *61,406* |
| Grapes, production (lbs.) | 10,679,108 | *15,116,920* |
| Forest products, value | $32,735,263 | *$11,364,134* |
| Nurseries: acres 989 in 62 establishments; receipts | $334,977 | |
| Greenhouses: sq. ft. under glass 453,691; receipts | $325,245 | |

### 3. Livestock, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock | 257,573; pure breds 10,057 | |
| Value all livestock on farms | $119,152,672 | *$62,649,984* |
| Horses, number | 171,436 | *166,151* |
| value | $21,907,650 | *$18,428,134* |
| Mules, number | 256,569 | *246,212* |
| value | $43,670,026 | *$* |
| All cattle, number | 644,779 | *700,861* |
| value | $28,797,982 | *$12,550,054* |
| Beef cattle, number | 182,702 | |
| Dairy cattle, number | 462,077 | *308,914* |
| Sheep, number | 90,556 | *214,473* |
| value | $783,668 | *$559,217* |
| Goats, number | 23,912 | *23,493* |
| value | $72,027 | *$43,039* |

| | | |
|---|---|---|
| Livestock products (*Continued*) | | |
| Swine, number | 1,271,270; | *1,227,625* |
| value | $16,006,895; | *$4,638,046* |
| Poultry, number | 7,827,935; | *5,053,870* |
| value | $7,324,880; | *$2,212,570* |
| Bees, number of hives | 163,956; | *189,178* |
| Livestock products, value | $35,860,056; | *$14,904,989* |
| Value all dairy products | $14,912,137; | *$5,789,583* |
| " eggs and chickens | $20,406,603; | *$8,753,536* |
| " wool and mohair | $185,223; | *$131,193* |
| " honey and wax | $356,093; | *$230,586* |
| Milk produced (gallons) | 95,747,638; | *82,601,779* |
| Butter made (lbs.) | 25,551,506; | *26,059,585* |
| Eggs produced (dozens) | 24,841,021; | *23,179,226* |



# NORTH DAKOTA

**NORTH DAKOTA** ("Flicker-Tail State"), one of the North Central States, lies between 45 and 49 degrees north latitude, and 96 and 105 degrees west longitude. The Red River of the North forms the eastern boundary. Area, 70,837 square miles, 654 of which are water.

**Land surface.** The state is in the Great Plains region, and is mostly rolling prairie. The Red River Valley is a broad, level plain at an elevation of about 1,000 feet above sea level extending down the eastern part. In the north are the Turtle Mountains, in the northeast the Pembina Mountains, in the southwest other scattered low elevations or sandstone buttes, and extending across the state from the northeast corner to the southern boundary east of the center, a plateau separating the Missouri River Valley from that of the Dakota. The Missouri River enters the state from Montana on the west, and flows east and south, leaving the state about midway of the southern border. Devil's Lake, northeast of the center, is salt and has no visible outlet. Many other small rivers flow into those named.

**Soils.** These are largely of a rich loam with clay subsoil. That of the Red River Valley is deep, very fertile and has long been noted as the finest of all hard-wheat belts. On the elevations, the soil is lighter; the rougher parts are best suited for grazing; but over most of the state, soil conditions are well adapted to general farming.

**Climate.** There are great extremes in temperature, but the dryness of the atmosphere here makes them entirely bearable and even very healthful. The average annual temperature for the eastern part is about 39 degrees, with extremes of 110 above and 53 below zero, and an average frost-free season of about 120 days; the average annual rainfall is about 19 inches. The western part has a slightly lower extreme winter temperature, an average frost-free season of about 115 days, and an average annual rainfall of about 17 inches. Snowfall is usually heavy.

**Opportunities.** With the development of irrigation projects, agricultural opportunities should increase. Information about land may be obtained from the Commissioner of Agriculture, Bismarck, or from the Agricultural Experiment Station, Fargo.

**Products and industries.** North Dakota's leading crops are wheat, oats, barley and flaxseed; in the production of the latter it leads the other states. The lack of moisture, dry, cold winters and heavy winds prevent extensive fruit growing, and vegetables are but little grown except for home or nearby consumption. Beef cattle, horses and swine are largely raised, and dairying is increasing in importance. It is predicted that apple growing will, in time, with the introduction of suitable varieties, become quite an industry in the southwestern part. Main minerals are lignite and natural gas. With the exception of milling, North Dakota is not much of a manufacturing state; the main manufactured products are flour, butter, cheese, condensed milk, and leathers.

**Transportation and markets.** The state is traversed from east to west by several leading railway systems. Principal east and west

railroad lines which, with their branches, afford excellent facilities, are the Northern Pacific, the Great Northern, and the Minneapolis, St. Paul and Sault Ste. Marie. There are no large cities, and the markets, except for the grain crops and livestock, are mostly local.

**History.** First explorations were by French Canadians in 1780, and by the Lewis and Clark Expedition in 1804–5. This region was included in the Louisiana Purchase of 1803, and was that part of Louisiana Territory renamed Missouri Territory, 1812. In 1849, the portion east of the Missouri River was made part of Minnesota Territory, and that west of the river became part of Nebraska Territory. Dakota Territory, formed in 1861, included the Dakotas, most of Montana, and a large part of Wyoming. In 1863, the Dakotas were reduced to their present limits. In 1889, the territory was divided "on the line of the seventh standard parallel," and the two newly formed areas were admitted to statehood as North Dakota and South Dakota.

**Agricultural organization.** Agricultural College and Experiment Station, *Fargo*; Substations, *Dickinson, Edgeley, Hettinger, Landon* and *Williston*. School of Forestry, *Bottineau*. The Commissioner of Agriculture and Labor and the Dairy Commissioner are located at *Bismarck*; Food Commissioner and Farmers' Institute Board at *Fargo*; State Fair Associations at *Grand Forks, Fargo* and *Mandan*; Dairymen's Association at *Bismarck*; Live Stock Association at *Fargo*. Horticultural Association at *Hankinson*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Population | 646,872; | *577,056* |
| City | 88,239 (13.6%); | *63,236 (11%)* |
| Country | 558,633 (86.4%); | *513,820 (89.%)* |
| Number of farmers | 77,690; | *74,360* |
| White | 77,147 (99.3%); | *73,617 (99%)* |
| Non-white | 543 (.7%); | *743 (1%)* |
| Land area, acres | 44,917,120 | |
| Acres in farms | 36,214,751; | *28,426,650* |
| Acres farm land improved | 24,563,178; | *20,455,092* |
| Average acres per farm | 466 (316 impr.) | *382 (275 impr.)* |
| Acres, artificially drained, 89,054 (.4% impr. farm land) | | |
| Acres needing drainage, 211,305 (.6% all farm land) | | |
| Farms by size, number: | | |
| Up to 19 acres | 314; | *229* |
| 20 " 49 " | 505; | *450* |
| 50 " 99 " | 917; | *1,207* |
| 100 " 174 " | 11,490; | *23,003* |
| 175 " 499 " | 42,078; | *34,393* |
| Over 500 " | 22,386; | *15,078* |
| Value all farm property | $1,759,742,995; | *$974,814,205* |
| Per cent increase in ten years | 80.5; | *281.9* |
| Value farm land | $1,279,313,627; | *$730,380,131* |
| " " buildings | $209,207,868; | *$92,276,613* |
| " " implements | $114,186,865; | *$43,907,595* |
| " " livestock | $157,034,635; | *108,249,866* |
| Av. value all property per farm | $22,651; | *$13,109* |
| " " land and buildings per acre | $41.10; | *$28.94* |
| Farms run by owners | 56,917 (73.6); | *63,212 (85.)* |
| Farms run by tenants | 19,918 (25.6%); | *10,664 (14.3%)* |
| Per cent owned farms unmortgaged | 22.5; | *48.5* |
| Per cent farms reporting automobiles 56.6; telephones 46.8 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $301,782,935; | *$180,311,555* |
| " " cereals | $215,764,634; | *$149,133,451* |
| Corn, acres | 191,428; | *185,122* |
| production (bu.) | 3,876,883; | *4,941,152* |
| 10-yr. av. yield per acre | 23.4 bu. | |
| Wheat, acres | 9,098,042; | *8,188,782* |
| production (bu.) | 61,540,404; | *116,781,886* |
| 10-yr. av. yield per acre | 10.9 bu. | |
| Oats, acres | 2,073,325; | *2,147,032* |
| production (bu.) | 30,294,074; | *65,886,702* |
| 10-yr. av. yield per acre | 25.8 bu. | |
| Rye, acres | 2,422,563; | *48,188* |
| production (bu.) | 16,294,377; | *689,233* |
| 10-yr. av. yield per acre | 13.2 bu | |
| Barley, acres | 1,085,329; | *1,215,811* |
| production (bu.) | 12,052,881; | *26,365,758* |
| 10-yr. av. yield per acre | 20 bu. | |
| Hay and forage, acres | 4,035,803; | *2,864,218* |
| production (tons) | 3,765,377; | *3,010,401* |
| value | $56,655,024; | *$12,369,030* |
| Potatoes, white, acres | 82,561; | *54,067* |
| production (bu.) | 4,717,556; | *5,551,430* |
| 10-yr. av. yield per acre | 91 bu. | |
| Buckwheat, acres | 1,286; | *1,039* |
| production (bu.) | 7,368; | *17,066* |
| Small fruits, acres | 524; | *399* |
| production (quarts) | 170,771; | *285,696* |
| Strawberries, acres | 93; | *88* |
| production (quarts) | 47,157; | *66,028* |
| Vegetables, acres 964; value | $13,725,227; | *$3,148,304* |
| Apples, production (bu.) | 14,358; | *4,374* |
| Pears, production (bu.) | 83; | *8* |
| Peaches, production (bu.) | 3; | *35* |
| Plums and prunes (bu.) | 5,660; | *1,048* |
| Grapes, production (lbs.) | 217; | *360* |
| Forest products, value | $206,317; | *$235,386* |
| Nurseries: No. 16; acres 388 receipts | $30,088 | |
| Greenhouses: sq. ft. of glass 179,212; receipts | $156,617 | |

### 3. Livestock, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock | 76,110; | pure breds 13,535 |
| Value all livestock on farms | $157,034,635; | *$108,249,866* |
| Horses, number | 855,682; | *650,599* |
| value | $72,168,452; | *$83,461,739* |
| Mules, number | 7,873; | *7,695* |
| value | $780,508; | *$1,149,001* |
| All cattle, number | 1,334,552; | *$743,762* |
| value | $67,911,737; | *$17,711,398* |
| Beef cattle, number | 674,529; | |
| Dairy cattle, number | 660,023; | *259,173* |
| Sheep, number | 298,912; | *293,371* |
| value | $3,573,689; | *$1,257,737* |
| Goats, number | 1,250; | *1,074* |
| value | $7,972; | *$5,618* |
| Swine, number | 458,265; | *331,603* |
| value | $8,884,986; | *$3,152,909* |
| Poultry, number | 4,608,449; | *3,268,109* |
| value | $3,667,531; | *$1,485,463* |
| Bees, number of hives | 708; | *495* |
| Livestock products, value | $30,979,932; | *$9,832,117* |
| Value all dairy products | $19,576,343; | *$4,872,304* |
| " eggs and chickens | $10,486,386; | *$4,576,089* |
| " wool and mohair | $913,551; | *$381,855* |
| " honey and wax | $3,652; | *$1,869* |
| Milk produced (gallons) | 138,606,540; | *70,637,899* |
| Butter made (lbs.) | 14,413,180; | *16,414,439* |
| Eggs produced (dozens) | 20,820,407; | *17,069,496* |

### 4. Irrigation, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Acres in irrigated projects | 57,476; | *38,173* |
| " of projects irrigable | 34,235; | *21,917* |
| " " " irrigated | 12,072; | *10,248* |
| Capital invested in projects | $1,857,188; | *$836,482* |
| Average investment, per acre | $54.25; | *$38.17* |
| Estimated final cost | $2,072,766; | *$836,482* |
| Average cost per acre | $36.06; | *$21.91* |
| " " maintainance and operation, per acre | $5.50; | *$28.40* |
| Acres of crops on irrigated land | 25,280 | |
| Value of crops on irrigated land | $267,148 | |
| Av. value crops on irrigated land, per acre (1919) | $10.57 | |

# OHIO

**OHIO** ("Buckeye State"), one of the North Central Corn Belt States, lies between 38 and 42 degrees north latitude and 80 and 85 degrees west longitude. The Ohio River forms the south and southeast boundaries, and Lake Erie two thirds of the northern boundary. Area, 41,040 square miles, 300 of which are water surface.

**Land surface.** A low-lying ridge crosses the State from northeast to southwest reaching its greatest height (1,540 feet) west of the center. From this the surface slopes toward Lake Erie on the north and the Ohio River on the south. The surface is hilly in the southeast, level in the west central part, and gently rolling over most of the rest of the state. The larger rivers are the Maumee, Sandusky, Vermilion, Black, Rocky, Cuyahoga, Grand and Ashtabula flowing into Lake Erie; the Little Beaver, Mahoning, Muskingum, Hocking, Scioto, Little Miami and Great Miami, flowing into the Ohio, and the St. Joseph flowing southwest across the northwest corner.

**Soils.** The eastern half of Ohio lies over sandstones and shales, except for limited areas in the coal measures. The western half lies over limestones. The underlying rocks have given the chief characteristics to the soils of the state, which have been modified by glacial action over all the state except the southeastern third. All are highly fertile and capable of intensive tillage. In the Ohio, Scioto and Miami Valleys, is much very fertile alluvial soil.

**Climate.** In the northeast, this is considerably modified by the effect of Lake Erie. The average annual temperature in the north is 49 degrees, with extremes of 105 degrees above and 32 degrees below zero. The average frost-free season ranges from 144 days in the interior to 195 days on the lake shore where the lowest recorded temperature is 16 degrees below zero. The average annual rainfall is 36.5 inches, lowest near the lake. In the southern and central parts, the average annual temperatures vary from about 50 degrees in the north to 55 degrees on the Ohio River, with extremes of 113 degrees above and 39 degrees below zero. The frost-free season averages about 164 days. The average annual rainfall is about 38 inches. The average annual snowfall varies from 15 to 54 inches at different stations throughout the State. Ohio lies in the track of the transcontinental storms from which some parts suffer occasionally. It is also subject to floods along some of its rivers.

**Opportunities.** There is no untaken public land suitable for agriculture.

**Products and industries.** Leading farm activities are the production of corn, oats, wheat, potatoes, hay and forage. Great quantities of fruits are grown, the leaders being apples, peaches, grapes and small fruits. The nursery business is of large proportions. Nearly all temperate-climate products are grown. All kinds of livestock are raised, both beef and dairy cattle, horses, sheep and swine, all being important. There are large numbers of high-class purebred flocks and herds. Considerable tobacco is grown in the west and southwest, and large quantities of vegetables wherever markets are easily reached. The state is a leader in beekeeping and honey production. Ohio was originally well covered with forests, largely hard wood, but these have been mostly cut. However, considerable timber is taken from the remaining forests and the second-growth trees. Leading minerals are soft coal, petroleum and natural gas. Ohio leads in clay products, brick, tile and pottery, and limestone is a valuable product. Main manufactures are iron and steel, the state ranking second in their production; foundry and machine-shop products; meat products; flour and cereal products, clothing, automobiles, lumber and timber products, boots and shoes, tobacco products, malt liquors, bakery prod-

ucts, carriages and wagons, pottery, furniture and refrigerators, agricultural implements, leather, butter, cheese, condensed milk.

**Transportation and markets.** Transportation facilities are unexcelled. Most of the transcontinental railroads cross the state, which contains many important railroad centers. There are many electric railways. Lake Erie furnishes water transportation to all the Upper Lakes territory, Canada and the East; the Ohio and its tributaries to the Mississippi Valley and the Gulf.

**History.** The Ohio Company received a grant of land, 1749. In 1763, the territory was ceded by France to England, and the same year the British Parliament annexed the region to Quebec. Ohio Territory was organized in 1800; it was authorized by Congress in 1802 to draft a constitution, and in 1803 was declared a state. The capital was first at Chillicothe. It was removed to Zanesville in 1810, but has been at Columbus since 1816. Population Columbus, 1910, 181,511.

**Agricultural organization.** Board of Agriculture, Colleges of Agriculture and of Veterinary Medicine, *Columbus*; Agricultural Experiment Station, *Wooster*. State Fair held at *Columbus*. There is a State Grange, State Horticultural Society and numerous livestock associations. The Experiment Station Director reports that the trend of agriculture in Ohio is towards an extension of drainage, a more systematic rotation of crops, a larger production and more careful saving and use of manure, and a larger use of limestone and chemical fertilizers.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population........................5,759,394; *4,767,121*
City.....3,677,136 (63.8%); *2,665,143 (55.9%)*
Country..2,082,258 (36.2%); *2,101,978 (44.1%)*
Number of farmers..................356,695; *272,045*
White...255,079 (99.4%); *270,095 (99.3%)*
Non-white........1,616, (6%); *1,950 (.7%)*
Land area, acres..........................26,073,600
Acres in farms..................23,515,888; *24,105,708*
Acres farm land improved........18,542,353; *19,227,969*
Av. acres per farm ....91.6 (72.2 impr.); *88.6 (77 impr.)*
Acres artificially drained, 7,365,532 (39.7% imp. farm land)
Acres needing drainage,..2,014,889 (8.6% all farm land)
Farms by size, number:
Up to 19 acres.....................31,479; *38,913*
20 " 49 " .....................44,535; *50,331*
50 " 99 " .....................86,337; *88,047*
100 " 174 " .....................69,738; *68,746*
175 " 499 " .....................23,773; *25,113*
Over 500 " ..................... 833; *895*
Value all farm property...$3,095,666,336; *$1,902,694,589*
Per cent increase in ten years................62.6; *58.7*
Value farm land.........$2,015,112,999; *$1,285,894,812*
Value farm buildings..... $646,322,950; *$368,257,594*
" " implements... $146,575,269; *$51,210,071*
" " livestock..... $287,655,118; *$197,332,112*
Av. value all property per farm.........$12,060; *$6,994*
" " land and buildings per acre....$113.18; *$68.62*
Farms run by owners 177,986 (69.3%); *192,104 (70.6%)*
Farms run by tenants ..75,644 (29.5%) ; *77,188 (28.4%)*
Per cent owned farms unmortgaged...........61.8; *70.6*
Per cent farms reporting automobiles 46.6; telephones 62.1

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops.........$607,037,562; *$221,086,342*
" " cereals...........$391,834,355; *$151,898,146*
Corn, acres............... 3,563,352; *3,916,050*
production (bu.).... 148,844,626; *157,513,300*
10-yr. av. yield per acre..............39.2 bu.
Wheat, acres............ 2,922,592; *1,827,932*
production (bu.).... 58,124,351; *30,663,704*
10-yr. av. yield per acre..............16.7 bu
Oats, acres.............. 1,452,052; *1,787,496*
production (bu.).... 46,818,330; *57,591,046*
10-yr. av. yield per acre..............37.2 bu.
Rye, acres.............. 116,464; *67,912*
production (bu.).... 1,666,449; *921,919*
10-yr. av. yield per acre..............16.3 bu.
Barley, acres............ 114,217; *24,075*
production (bu.).... 2,412,196; *569,279*
10-yr. av. yield per acre..............28.3 bu.
Hay and forage, acres....... 4,917,259; *3,306,461*
production (tons)... 7,661,890; *4,521,509*
value.............$130,187,929; *$42,362,114*
Buckwheat, acres........... 30,412; *26,073*
production (bu.).... 321,688; *144,861*
Potatoes, white, acres....... 124,917; *212,808*
production (bu.).... 7,513,960; *20,322,984*
10-yr. av. yield per acre................79 bu.
Sweet, acres ............. 2,584; *1,143*
production (bu.).... 224,774; *133,798*
10-yr. av. yield per acre...............103 bu.
Tobacco, acres............. 75,789; *106,477*
production (lbs.).... 64,420,472; *88,603,308*
10-yr. av. yield per acre..............910 lbs.
Sugar beets, acres.......... 33,561; *7,009*
production (tons)... 365,415; *63,546*
Sorghum, acres............ 5,464; *4,587*
production (tons)..... 24,256; *28,137*
Maple sugar, trees tapped.... 2,269,199; *3,170,828*
sugar made (lbs.)... 62,001; *257,592*
syrup made (gals.).. 694,175; *1,323,431*
Small fruits, acres.......... 9,447; *11,591*
production (quarts). 11,963,128; *15,721,023*
Strawberries, acres.......... 4,172; *4,706*
production (quarts). 7,165,957; *8,501,065*
Vegetables, acres 62,860; value $43,365,158; *$20,875,927*
Apples, production (bu.)..... 2,976,436; *4,663,752*
Pears, production (bu.)...... 157,492; *374,871*
Peaches, production (bu.).... 617,537; *1,036,340*
Plums and prunes (bu.)...... 84,602; *215,657*
Grapes, production (lbs.).... 41,722,796; *43,933,207*
Forest products, value....... $11,364,709; *$5,761,941*
Nurseries: acres 2,789 in 168 establishments:
receipts..........................$1,286,947
Greenhouses: sq. ft. under glass 19,397,183;
receipts..........................$7,052,560

### 3. Livestock, 1920 and *1910*

Number farms reporting livestock............. 245,572; pure breds 33,365
Value all livestock on farms..$286,665,118; *$197,332,112*
Horses, number........... 810,692; *910,224*
value ............ $76,729,266; *$98,910,638*
Mules, number............ 31,626; *22,850*
value............. $3,647,955; *$2,775,831*
All cattle, number........ 1,926,823; *1,837,607*
value.............$118,581,927; *$51,403,341*
Beef cattle, number..... 577,450;
Dairy cattle, number.... 1,349,373; *905,125*
Sheep, number........... 2,102,550; *3,909,162*
value............. $19,020,588; *$14,941,381*
Goats, number........... 4,027; *5,379*
value............. $23,165; *$17,843*
Swine, number........... 3,083,846; *3,105,627*
value............. $48,485,251; *$19,412,730*
Poultry, number.......... 20,604,103; *17,342,289*
value............. $20,693,940; *$9,532,672*
Bees, number of hives..... 105,675; *98,242*
Livestock products, value....$155,587,919; *$68,500,279*
Value all dairy products... $81,148,586; *$30,869,408*
" eggs and chickens... $64,109,133; *$30,746,291*
" wool and mohair.... $10,075,214; *$6,750,689*
" honey and wax...... $254,986; *$133,891*
Milk produced (gallons)... 396,317,787; *307,590,755*
Butter made (lbs.)........ 30,264,265; *63,569,132*
Eggs produced (dozens).... 102,377,143; *100,284,261*

are flour and cereal products; cottonseed oil and cake; lumber and timber products, bakery products; foundry and machine-shop products; manufactured ice; butter, cheese and condensed milk; brick and tile.

**Transportation and markets.** Transportation facilities are excellent for a new state. A large part of the area is well covered by railroads. The Arkansas and Red rivers are navigable for considerable distance for boats of light draft, which gives communication by water with the Mississippi and the Gulf.

**History.** Oklahoma was a part of the original Louisiana Purchase, except what was known for many years as the Public Land Strip, which was ceded by Texas to the United States in 1850, and added to Oklahoma in 1890. This country was early set aside as the "Indian Country," and was to remain unorganized. Between 1825 and 1850, the Indian tribes of the Five Nations were granted large tracts in the Indian Territory. Later large areas of these were ceded to the United States, and some of this land granted to other Indian tribes. In 1889, the vacant lands were thrown open to homeseekers. In 1893, the Cherokee Strip was opened. Other reservations were added in succeeding years. In 1890, Oklahoma Territory was set apart from Indian Territory. In 1905 a joint statehood bill was passed by Congress, and in 1907, Oklahoma was admitted to statehood. Capital, Oklahoma City; population 1910, 64,205.

**Agricultural organization.** Agricultural and Mechanical College and Experiment Station, *Stillwater*; Agricultural and Normal University, *Langston*; Coöperative Demonstration Work, *Yukon*; District Agricultural Schools, *Tishomingo, Broken Arrow, Warner, Helena Lawton, Goodwell*; Board of Agriculture, *Oklahoma City*; Agricultural Association, *McAlester*; State Fair Association, *Oklahoma City*; New State Fair Association, *Muskogee*; Game and Fish Protective Association, *Oklahoma City*.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Population | 2,028,283 | *1,657,155* |
| City | 539,480 (26.6%) | *320,155 (19.3%)* |
| Country | 1,488,803 (73.4%) | *1,337,000 (80.7%)* |
| Number of farmers | 191,988 | *190,192* |
| White | 173,263 (90.2%) | *169,521 (89.1%)* |
| Non-white | 18,725 (9.8%) | *20,671 (10.9%)* |
| Land area, acres | 44,424,960 | |
| Acres in farms | 31,951,934 | *28,859,353* |
| Acres farm land improved | 18,215,321 | *17,551,337* |
| Average acres per farm | 166 (94.4 impr.) | *151* (*92.3* impr.) |
| Farm land artificially drained, acres | 107,014 (.6% impr. farm land) | |
| Farm land needing drainage, acres | 265,786 (.8% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 6,024 | *7,158* |
| 20 " 49 " | 32,558 | *31,489* |
| 50 " 99 " | 43,452 | *39,002* |
| 100 " 174 " | 66,245 | *75,186* |
| 175 " 499 " | 37,652 | *33,812* |
| Farms by size, number (*continued*): | | |
| Over 500 " | 6,057 | *3,545* |
| Value all farm property | $1,660,423,544 | *$918,198,882* |
| Per cent increase in ten years | 80.8 | *230.9* |
| Value farm land | $1,171,459,364 | *$649,066,668* |
| " " buildings | $192,405,930 | *$89,610,556* |
| " " implements | $80,630,547 | *$27,088,866* |
| " " livestock | $215,927,703 | *$152,432,792* |
| Av. value all property per farm | $8,649 | *$4,828* |
| " " land and buildings per acre | $42.68 | *$25.60* |
| Number farms run by owners | 93,217 (48.5%) | *85,404 (44.7%)* |
| Number farms run by tenants | 97,836 (51%) | *184,137 (54.8%)* |
| Per cent owned farms unmortgaged | 32.8 | *54.9* |
| Per cent farms reporting automobiles 25.5; telephones 37.3 | | |

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $550,084,742 | *$131,522,220* |
| " " cereals | $276,229,521 | *$71,798,662* |
| Corn, acres | 2,472,905 | *5,914,069* |
| production (bu.) | 53,851,093 | *94,283,407* |
| 10-yr. av. yield per acre | 16 bu. | |
| Wheat, acres | 4,702,280 | *1,169,420* |
| production (bu.) | 65,671,843 | *14,008,334* |
| 10-yr. av. yield per acre | 12.5 bu. | |
| Oats, acres | 1,573,055 | *609,573* |
| production (bu.) | 45,470,191 | *16,606,154* |
| 10-yr. av. yield per acre | 23.1 bu. | |
| Rye, acres | 71,680 | *4,291* |
| production (bu.) | 705,124 | *37,240* |
| 10-yr. av. yield per acre | 12 bu. | |
| Cotton, acres | 2,732,962 | *1,976,935* |
| production (bales) | 1,006,242 | *555,742* |
| 10-yr. av. yield per acre | 168 lbs. | |
| Hay and forage, acres | 2,073,513 | *1,347,598* |
| production (tons) | 3,038,396 | *1,477,533* |
| Value | $50,072,900 | *$9,877,704* |
| Potatoes, white, acres | 25,633 | *32,295* |
| production (bu.) | 1,924,194 | *1,897,486* |
| 10-yr. av. yield per acre | 61 bu. | |
| Sweet, acres | 16,735 | *5,056* |
| production (bu.) | 1,844,463 | *359,451* |
| 10-yr. av. yield per acre | 92 bu. | |
| Peanuts, acres | 13,969 | *1,564* |
| production (bu.) | 297,465 | *31,880* |
| Barley, acres | 77,324 | *10,283* |
| production (bu.) | 1,781,839 | *127,641* |
| 10-yr. av. yield per acre | 19.2 bu. | |
| Sorghum, acres | 15,803 | *12,940* |
| production (tons) | 53,181 | *35,195* |
| Small fruits, acres | 2,649 | *2,745* |
| production (quarts) | 1,899,073 | *2,310,367* |
| Strawberries, acres | 302 | *825* |
| production (quarts) | 311,630 | *830,404* |
| Vegetables, acres 11,918; value | $17,516,349 | *$4,210,844* |
| Apples, production (bu.) | 1,596,975 | *742,182* |
| Pears, production (bu.) | 249,586 | *7,450* |
| Peaches, production (bu.) | 2,924,842 | *357,644* |
| Plums and prunes (bu.) | 127,811 | *25,916* |
| Grapes, production (lbs.) | 3,888,492 | *3,762,727* |
| Forest products, value | $3,508,813 | *$1,602,720* |
| Nurseries: acres 641 in 76 establishments; receipts | $79,222 | |
| Greenhouses: sq. ft. under glass 722,971; receipts | $534,705 | |

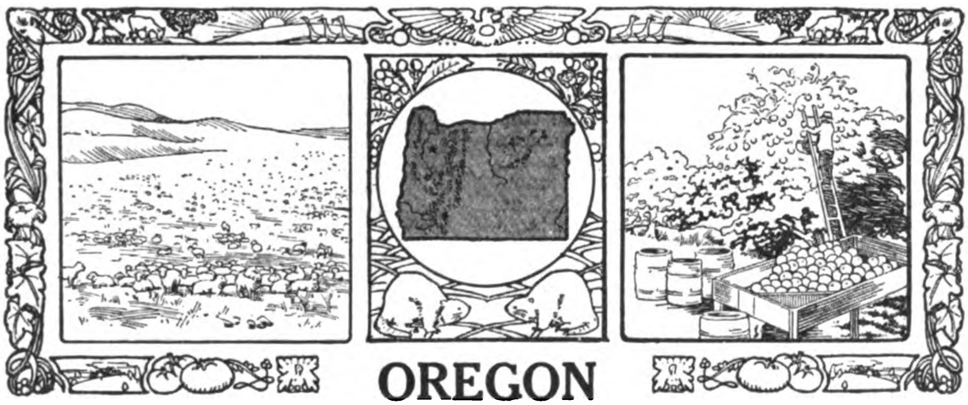
**3. Livestock, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock | 185,329; pure breds 21,228 | |
| Value all livestock on farms | $215,927,703 | *$152,432,792* |
| Horses, number | 738,443 | *742,959* |
| value | $58,734,170 | *$63,651,661* |
| Mules, number | 336,365 | *257,066* |
| value | $39,892,069 | *$28,618,224* |
| All cattle, number | 2,073,945 | *1,953,560* |
| value | $87,199,975 | *$43,187,601* |
| Beef cattle, number | 1,265,486 | |
| Dairy cattle, number | 808,459 | *530,796* |
| Sheep, number | 105,370 | *62,472* |
| value | $1,123,033 | *$253,864* |
| Goats, number | 45,825 | *25,591* |
| value | $229,635 | *$62,687* |
| Swine, number | 1,304,094 | *1,839,030* |

| | | |
|---|---|---|
| Swine, value | $17,000,355; | *$11,997,641* |
| Poultry, number | 11,614,851; | *8,501,237* |
| value | $10,836,525; | *$3,713,943* |
| Bees, number of hives | 46,743; | *19,413* |
| Livestock products, value | $49,887,518; | *$20,379,510* |
| Value all dairy products | $20,878,920; | *$7,365,295* |
| " eggs and chickens | $28,635,007; | *$12,932,578* |
| " wool and mohair | $268,724; | *$57,541* |
| " honey and wax | $104,867; | *$24,096* |
| Milk produced (gallons) | 135,820,769; | *103,577,644* |
| Butter made (lbs.) | 22,214,546; | *27,056,242* |
| Eggs produced (dozens) | 45,440,017; | *45,356,592* |

**4. Irrigation, 1920 and *1910***

| | |
|---|---|
| Acres in irrigated projects | 11,742; *8,528* |
| " of projects irrigable | 9,672; *6,397* |
| " " " irrigated | 2,969; *4,388* |
| Capital invested in projects | $151,325; *$47,200* |
| Average investment, per acre | $15.65; *$7.38* |
| Estimated final cost | $162,775; *$47,200* |
| Av. cost per acre | $13.86; *$5.53* |
| " " maintenance and operation, per acre | $2.92; *$0.51* |



# OREGON

**OREGON** ("Beaver State"), one of the Pacific States, lies between 42 and 47 degrees north latitude, and 116 and 125 degrees west longitude. The Columbia River forms a large part of the northern boundary, and the Snake River about half of the eastern. Area, 96,699 square miles, 1,092 of which are water.

**Land surface.** Oregon is divided into eastern and western sections by the Cascade Mountains, which cross it from north to south about 120 miles back from the coast. These mountains range from 4,000 to 11,225 feet in height, the highest peak being Mt. Hood, near the northern border. The Coast Range, with an average elevation of 2,000 feet, with some peaks 3,500 feet or more in height, runs parallel with the coast and is met by projections from the Cascades, in the south. Between these two ranges, that is, in western Oregon, are the three important agricultural valleys—those of the Willamette, Umpqua and Rogue rivers. The narrow strip of land between the Coast Range and the Ocean consists of rolling hills, narrow valleys, tidal flats, sea beaches, high bluffs, rivers and mountain slopes where grass grows the year 'round. East of the Cascades, embracing about two thirds of the state, is a gently rolling tableland with a general elevation of 2,600 to 4,700 feet but cut by many deep cañons. The Blue Mountains in the north reach 7,000 feet. In this region are several fertile valleys. In the south is the Great Sandy Desert, where many small streams and lakes with no visible outlets are found.

**Soils.** In western Oregon, the Willamette and other coast valleys consist of alluvial deposits and silt, clay loams and sandy loams, the higher levels of red clay and sandy loams adapted more to natural grasses and grazing. In eastern Oregon, in the valley and plateau region of the Columbia, are great areas of fertile wheat land. In the Grande Ronde Valley are immense areas of fertile loam suitable for all crops. Farther south, much of the soil is volcanic or sandy with much alkali, but under irrigation produces good crops.

**Climate.** West of the Cascade Mountains the climate is much milder and moister than east of them. The average annual temperature of western Oregon ranges from 42 degrees on the mountains to 53 degrees in the valleys. Temperatures above 100 and below zero are rare. The frost-free season ranges from 303 days on the coast to 245 days in some of the lower valleys; on some of the higher mountains, of course, there is practically no frost-free period. The average annual rainfall for the year for this section, which falls mostly from October to May, varies from 20.2 inches in a protected valley to 133 inches at a station near the coast. In the eastern section, the average annual temperature is about 49.5 degrees, being highest in the lowlands along the Columbia River and lowest in the mountains. The frost-free season is more than 200 days in some favored localities, but in others frosts may occur during any month. The average annual rainfall varies from 8 inches at some of the lower ele-

vations to 50 to 60 inches on the mountains. The snowfall throughout the state also varies widely from the mild coast section, to the cold inland mountain heights.

**Opportunities.** In 1915, the unappropriated public land in Oregon comprised about 15,000,000 acres. The State Immigration Commission says: "Oregon offers opportunity for homemaking to those who bring the capital of strength, ambition and enough for fair investment. No comfort is offered idleness. No vision of fortune without work will be realized here." There are suitable lands and locations for those who wish to engage in any branch of agriculture, horticulture or livestock. Information may be obtained from the Oregon Development Bureau, Portland. Information about irrigated lands may be obtained from the U. S. Reclamation Service, Washington, D. C.

**Products and industries.** Leading farm activities are the production of wheat, oats, barley, hops and potatoes. Oregon produces nearly half the hops grown in the United States. Some of the finest flax in the world, equaled only by that of Ireland and Belgium, is also grown here. Apples are the leading fruit crop, those from the Hood River Valley being world famous; all the other tree fruits thrive, as do grapes and small fruits. Vegetables of all kinds grow to perfection. The most important livestock are sheep and Angora goats, horses, swine and cattle following in order. Poultry do well and the demand exceeds the production. Lumbering is a very important industry, more than half the state being heavily timbered. The state is among the foremost in fisheries, salmon being the most important, and the canning industry extensive. Oregon has a great variety of minerals, but none in very large quantities. The principal one is gold, and there is some coal, silver and copper. Manufacturing has not been extensively developed, though there are many natural advantages in the way of unlimited water power, transportation and raw materials. Leading manufactures are lumber products, flour and grist-mill products, meat products, canned fish, butter, cheese and condensed milk, paper and wood pulp.

**Transportation and markets.** West of the Cascade Range and along the Columbia River, railway lines are fairly numerous, but the great southeastern part is without railroads. The Pacific Ocean gives a great opportunity for foreign and coastwise trade. The Columbia River is navigable for large steamers to the Dalles, and to Portland by ocean steamers. The Columbia above the Dalles, and the Snake as far as the eastern boundary, are navigated by smaller craft. Oregon has a road-building policy that promises a unified system of permanent highways, and that has already resulted in road construction costing millions of dollars. Portland and Astoria are leading export markets.

**History.** First explorations were made along the coast by the Spaniards in 1543, and by Sir Francis Drake in 1579. In 1778, Captain Cook touched the coast at Nootka Sound and confirmed the English title to the Oregon territory. Fur traders visited the coast, and the Lewis and Clark Expedition reached the Columbia in 1805. First agricultural settlement in 1829. After 1840, immigration increased rapidly and trouble arose between American settlers and British traders which was finally settled in 1846, by a joint commission which made the forty-ninth parallel the boundary between the American and British possessions. Oregon was made a territory in 1848, and admitted to statehood in 1859. Capital, Salem; population, 1910, 14-094.

**Agricultural organization.** Agricultural College and Experiment Station, *Corvallis*, Branch stations, *Union*, *Hermeston*, *Noro*, *Talent*, *Burns*, *Astoria*. Fruit Growers' Association, State Board of Horticulture, *Portland*. There are, also, the Grange, Farmers' Educational Coöperative Union, Farmers' Fire Relief Association, Nurserymen's Association, Live Stock Sanitary Board, Board of State Fair Directors, Stallion Registration Board, Pure Seed Board.

### Statistics

#### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 783,389; *672,765* |
| City | 391,019 (68%); *307,060 (61.8%)* |
| Country | 392,370 (32%); *365,705 (38.2%)* |
| Number of farmers | 50,206; *45,502* |
| White | 49,633 (98.9%); *44,875 (98.6%)* |
| Non-white | 573 (1.1%); *627 (1.4%)* |
| Land area, acres | 61,188,480 |
| Acres in farms | 13,542,318; *11,685,110* |
| Acres farm land improved | 4,913,851; *4,274,803* |
| Average acres per farm | 269.7 (97.8 impr.); *256.8* (*94* impr.) |
| Farm land artificially drained, acres | 229,582 (4.7% impr. farm land) |
| Farm land needing drainage, acres | 471,396 (3.5% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 7,526; *6,030* |
| 20 " 49 " | 8,755; *6,888* |
| 50 " 99 " | 8,302; *6,800* |
| 100 " 174 " | 9,735; *12,009* |
| 175 " 499 " | 10,310; *9,343* |
| Over 500 " | 5,578; *4,432* |
| Value all farm property | $818,559,751; *$528,243,782* |
| Per cent increase in ten years | 42.39; *205.8* |
| Value farm land | $586,242,04[illegible]; *$411,696,102* |
| " " buildings | $88,971,235; *$43,880,207* |
| " " implements | $41,567,125; *$13,205,645* |
| " " livestock | $101,779,342; *$59,461,828* |
| Av. value all property per farm | $16,304; *$11,609* |
| " " land and buildings per acre | $49.86; *$38.99* |
| Number farms run by owners | 39,863 (79.4%); *37,796 (83%)* |
| Number farms run by tenants | 9,427 (18.8%); *6,859 (151.1%)* |
| Per cent owned farms unmortgaged | 45.3; *65.8* |
| Per cent farms reporting automobiles 41; telephones 50.5 | |

#### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $131,884,639; | *$45,064,450* |
| " " cereals | $53,980,152; | *$17,860,136* |
| Corn, acres | 31,972; | *17,280* |
| production (bu.) | 846,642; | *451,757* |
| 10-yr. av. yield per acre | | 30.5 bu. |

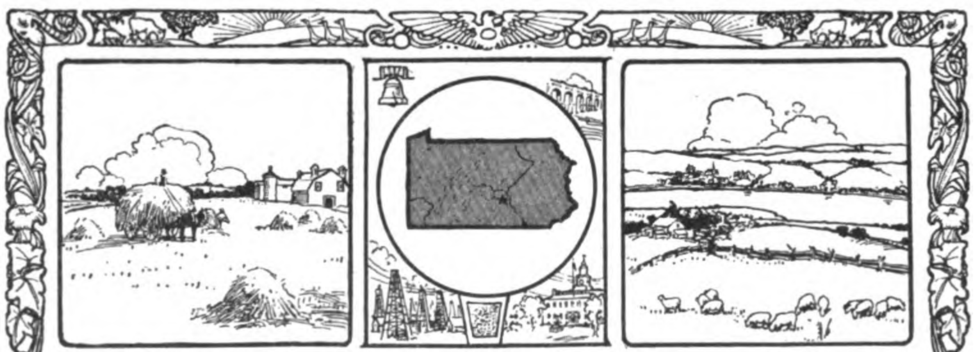
| | | |
|---|---|---|
| Wheat, acres | 1,080,051; | *763,187* |
| production (bu.) | 19,526,765; | *2,456,751* |
| 10-yr. av. yield per acre | 20.2 bu. | |
| Oats, acres | 284,152; | *339,162* |
| production (bu.) | 8,357,406; | *10,881,286* |
| 10-yr. av. yield per acre | 36 bu. | |
| Rye, acres | 42,476; | *12,913* |
| production (bu.) | 312,463; | *147,024* |
| 10-yr. av. yield per acre | 15 bu. | |
| Barley, acres | 66,595; | *108,847* |
| production (bu.) | 1,429,073; | *2,377,735* |
| 10-yr. av. yield per acre | 31.9 bu. | |
| Hay and forage, acres | 1,229,404; | *939,979* |
| production (tons) | 2,197,619; | *1,587,796* |
| value | $41,835,706; | *$15,276,648* |
| Potatoes, white, acres | 40,055; | *44,265* |
| production (bu.) | 3,538,930; | *$4,822,962* |
| 10-yr. av. yield per acre | 122 bu. | |
| sweet, acres | 10; | *5* |
| production (bu.) | 923; | *843* |
| Buckwheat, acres | 477; | *161* |
| production (bu.) | 2,625; | *3,318* |
| Small fruits, acres | 8,463; | *5.124* |
| production (quarts) | 18,977,822; | *9,348,490* |
| Strawberries, acres | 2,812; | *2,941* |
| production (quarts) | 4,159,200; | *5,322,040* |
| Vegetables, acres 6,231: value | $11,762,494; | *$4,548,523* |
| Apples, production (bu.) | 6,921,284; | *$1,930,926* |
| Pears, production (bu.) | 761,063; | *374,622* |
| Peaches, production (bu.) | 504,441; | *179,030* |
| Plums and prunes (bu.) | 2,151,864; | *1,747,587* |
| Grapes, production (lbs.) | 2,842,656; | *3,206,874* |
| Forest products, value | $5,299,123; | *$2,889,991* |
| Nurseries: acres 1,212 in 68 establishments; receipts | $344,168 | |
| Greenhouses: sq. ft. under glass 1,627,293; receipts | $584,665 | |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 47,003; | pure breds 8,293 |
| Value all livestock on farms | $101,779,342; | *$59,461,828* |
| Horses, number | 271,559; | *271,708* |
| value | $19,225,842; | *$25,181,143* |
| Mules, number | 14,375; | *9,927* |
| value | $1,589,552; | *$1,185,788* |
| All cattle, number | 851,108; | *725,255* |
| value | $47,818,486; | *$17,570,685* |
| Beef cattle, number | 134,748; | |
| Dairy cattle, number | 280,411; | *172,550* |
| Sheep, number | 2,002,378; | *2,699,135* |
| value | $24,423,544; | *$12,213,942* |
| Goats, number | 133,685; | *185,411* |
| value | $585,456; | *$370,637* |
| Swine, number | 266,778; | *217,577* |
| value | $4,664,307; | *$1,570,949* |
| Poultry, number | 2,573,536; | *1,823,680* |
| value | $3,058,515; | *$1,067,743* |
| Bees, number of hives | 45,264; | *47,285* |
| Livestock products, value | $35,146,671; | *$14,401,942* |
| Value all dairy products | $17,651,409; | *$6,067,024* |
| " eggs and chickens | $9,018,444; | *$4,329,457* |
| " wool and mohair | $8,230,902; | *$3,910,951* |
| " honey and wax | $245,916; | *$94,510* |
| Milk produced (gallons) | 92,844,946; | *56,106,599* |
| Butter made (lbs.) | 4,177,628; | *5,667,964* |
| Eggs produced (dozens) | 14,625,720; | *11,835,462* |

### 4. Irrigation, 1920 and *1910*

| | | |
|---|---|---|
| Acres in irrigated projects | 1,925,987; | *2,527,208* |
| " of projects irrigable | 1,344,046; | *830,526* |
| " " " irrigated | 986,162; | *686,126* |
| " " irrigated land open to settlement | 98,609 | |
| Capital invested in projects | $28,929,151; | *$12,760,214* |
| Average investment, per acre | $21.52; | *$15.36* |
| Estimated final cost | $41,585,742; | *$39,216,619* |
| Average cost per acre | $21.59; | *$15.52* |
| " " maintenance and operation, " per acre | $1.19; | *$0.75* |
| Acres of crops on irrigated land | 274,584 | |
| Value of crops on irrigated land | $12,294,191 | |
| Av. value crops on irrigated land, per acre, (1919) | $44.77 | |



# PENNSYLVANIA

**PENNSYLVANIA** ("Keystone State"), named after William Penn, the name meaning Penn's Woodland, is one of the North Atlantic States and lies between 39 and 43 degrees north latitude, and 74 and 81 degrees west longitude. Its extreme length east to west is 302 miles, its breadth, 158 miles. The Delaware River forms its entire eastern boundary. Area, 45,126 square miles, 296 of which are water.

**Land surface.** The State is crossed from the northeast corner to the southwest by the Appalachian Mountains which form a belt of parallel ranges and narrow valleys about 50 miles broad, making up, therefore, about a quarter of the state. The highest point in

the State is Blue Knob, 3,136 feet. The southeast corner is generally level, with elevations of from 75 to 500 feet at the base of the mountains where are found rounded hills and broad, fertile valleys. North and west of the mountain region occupying about half the state, is a broad plateau from 700 to 2,000 feet elevation with a rolling surface dotted with numerous low, flat-topped hills. The extreme eastern part drains into the Delaware River; the east-central part into the Susquehanna, which flows entirely across the State; and the western part into the Ohio, which is formed by the Allegheny from the north, rising in New York State, and the Monongahela from the south, rising in West Virginia. The extreme northwest corner drains into Lake Erie.

Soils. These are largely limestone or alluvial, the former prevailing in the valleys west of the Delaware Valley. In the south and southeast, the soils are extremely fertile, Lancaster County being recognized as one of the richest agricultural counties in the United States. These are adapted to general farming and trucking. The northern part is better adapted to dairying and fruit growing.

Climate. The western part is subject to greater extremes and lower winter temperatures than the eastern. The highest recorded temperature is 104 degrees above and the lowest, 30 degrees below zero. The frost-free season averages about 180 days and the average annual rainfall is about 42 inches, being heaviest in the southeastern part. The annual snowfall is about 44 inches. Disastrous floods sometimes occur in the river valleys. In the east, the winters are mild, zero temperatures being rare in the southeast. The climate is more humid, rendering the heat of summer more oppressive. In this section and also in the central Susquehanna Valley country, the extreme temperatures and the average annual temperatures, rainfall and snowfall are not far from those given above. To the southward and at the lower levels, the temperatures run higher and the frost-free season longer, as would naturally be expected.

Opportunities. While most of the cleared land of the state is under cultivation, farms in certain sections can be bought at a low price per acre. This is particularly true of farms located on soils of the so-called De Kalb series, some of which need liming and fertilizing. The Agricultural Experiment Station conducted lime and fertilizer experiments on the De Kalb soil in Centre County, the results indicating that such lands can be farmed profitably when properly treated with lime and commercial fertilizers. A list of farms for sale may be obtained from the State Department of Agriculture, Harrisburg.

Products and industries. No state has a greater variety of products. Leading farm activities are the production of corn, oats and wheat, hay and forage crops. Tobacco is grown extensively in Lancaster County. Immense quantities of vegetables are grown especially in the southeastern part. Apples, peaches and grapes are the leading fruits, the latter largely in the northwest. An important industry is the growing of garden seeds, Philadelphia being a center of the seed trade. Of livestock, dairy cattle are probably the most important, many full registered herds being found around Philadelphia, where also some excellent horses are raised. Farther out in the country, beef cattle are numerous. Grazing conditions are excellent for cattle and sheep. Lumbering is an important industry though much of the merchantable timber has been removed. Pennsylvania surpasses all other states in the value of mineral products. The leading ones are coal, both hard and soft, petroleum, natural gas, building stone and slate. Main manufactures are iron and steel, foundry and machine-shop products, leather, petroleum products, silk goods, flour and cereal products, and coke. Leading manufacturing cities are Pittsburgh, Philadelphia, and Bethlehem.

**Transportation and markets.** Only two states have a greater mileage, or more railways per square mile. Lake Erie gives water communication to all the Great Lakes region. The Ohio River furnishes a water outlet to the Mississippi and the Gulf of Mexico; and Delaware River and Bay provide for coast trade and foreign commerce. Philadelphia and Erie are ports of entry. The many canals in the state are less important than formerly. Leading market cities are Philadelphia and Pittsburgh, but all of the mining and manufacturing towns furnish excellent markets.

History. The shores of Delaware Bay were visited by different explorers from 1524 on. In 1638, the Swedes founded New Sweden on the Delaware River, but were conquered by the Dutch of New Netherland in 1655. In 1681, William Penn received a grant of the region forming the present state, and Philadelphia was laid out in 1682. In the same year Penn made a treaty with the Indians. Delaware was included with Penn's holdings, and there were many disputes over boundaries which were not finally settled till 1792. In 1774, Philadelphia was selected as the meeting place of the Continental Congress. The Declaration of Independence was signed at Philadelphia in 1776, and the State ratified the United States Constitution in 1787. In 1780 it provided for the gradual emancipation of its slaves. Capital, Harrisburg; population, 1910, 64,186.

Agricultural organization. College of Agriculture and Experiment Station, *State College*. State Board of Agriculture, *Harrisburg*. There are also a State Horticultural Society, Pennsylvania Breeders' and Dairymen's Association, Rural Progress Association, State Grange, Institute of Animal Nutrition, and

**many county and local associations. There is no state fair, but an Interstate Fair is held annually at *Trenton, New Jersey.***

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Population | 8,720,017 | *7,665,111* |
| City | 5,607,815 (64.3%) | *4,630,669 (60.4%)* |
| Country | 3,112,202 (35.7%) | *3,034,442 (39.6%)* |
| Number of farmers | 202,250 | *219,295* |
| White | 201,799 (99.8%) | *218,749 (99.8%)* |
| Non-white | 451 (.2%) | *546 (.2%)* |
| Land area, acres | 28,692,480 | |
| Acres in farms | 17,657,513 | *18,586,832* |
| Acres farm land improved | 11,847,719 | *12,673,519* |
| Average acres per farm | 87.3 (58.5 impr.) | *84.8 (57.8 impr.)* |
| Farm land artificially drained, acres | 318,955 (2.7% impr. farm land) | |
| Farm land needing drainage, acres | 554,690 (3.1% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 31,963 | *38,658* |
| 20 " 49 " | 36,462 | *39,721* |
| 50 " 99 " | 62,172 | *65,687* |
| 100 " 174 " | 52,839 | *55,518* |
| 175 " 499 " | 18,026 | *18,912* |
| Over 500 " | 798 | *799* |
| Value all farm property | $1,729,353,034 | *$1,153,274,862* |
| Per cent increase in ten years | 37.1 | *19.2* |
| Value farm land | $726,158,051 | *$630,430,010* |
| " " buildings | $600,593,977 | *$410,638,740* |
| " " implements | $163,826,365 | *$70,726,055* |
| " " livestock | $238,774,641 | *$141,480,052* |
| Av. value all property per farm | $8,551 | *$5,715* |
| " " land and buildings per acre | $75.14 | *$56.01* |
| Number farms run by owners | 153,498 (75.9%) | *164,229 (74.8%)* |
| Number farms run by tenants | 44,262 (21.9%) | *51,105 (23.3%)* |
| Per cent owned farms unmortgaged | 61.1 | *68.3* |

Per cent farms reporting automobiles 34.5; telephones 43.5

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $409,968,877 | *$153,472,094* |
| " " cereals | $187,178,692 | *$10,348,726* |
| Corn, acres | 1,346,404 | *1,380,671* |
| production (bu.) | 61,450,012 | *41,494,237* |
| 10-yr. av. yield per acre | 41.7 bu. | |
| Wheat, acres | 1,424,951 | *1,225,558* |
| production (bu.) | 23,453,978 | *21,564,479* |
| 10-yr. av. yield per acre | 17.3 bu. | |
| Oats, acres | 1,175,509 | *1,144,248* |
| production (bu.) | 29,183,172 | *28,172,686* |
| 10-yr. av. yield per acre | 33.5 bu. | |
| Rye, acres | 242,989 | *272,560* |
| production (bu.) | 3,208,003 | *3,496,603* |
| 10-yr. av. yield per acre | 16.9 bu. | |
| Barley, acres | 17,385 | *7,625* |
| production (bu.) | 261,847 | *136,239* |
| 10-yr. av. yield per acre | 26.6 bu. | |
| Hay and forage, acres | 3,767,122 | *3,088,105* |
| production (tons) | 5,956,269 | *3,677,307* |
| value | $115,341,367 | *$45,630,282* |
| Potatoes, white, acres | 233,981 | *262,013* |
| production (bu.) | 22,051,685 | *21,740,161* |
| 10-yr. av. yield per acre | 89 bu. | |
| Sweet, acres | 2,424 | *1,306* |
| production (bu.) | 175,755 | *128,770* |
| 10-yr. av. yield per acre | 117 bu. | |
| Buckwheat, acres | 249,654 | *292,728* |
| production (bu.) | 4,755,739 | *4,797,350* |
| 10-yr. av. yield per acre | 19.6 bu. | |
| Maple sugar, trees tapped | 1,020,181 | *1,298,005* |
| sugar made (lbs.) | 535,954 | *1,188,049* |
| syrup made (gals.) | 273,672 | *391,242* |
| Tobacco, acres | 42,799 | *41,742* |
| production (lbs.) | 55,965,851 | *46,164,800* |
| 10-yr. av. yield per acre | 1,388 lbs. | |
| Small fruits, acres | 8,680 | *8,678* |
| production (quarts) | 10,953,818 | *13,620,047* |
| Strawberries, acres | 4,008 | *4,136* |
| production (quarts) | 7,184,096 | *9,033,904* |
| Vegetables, acres 54,283; value | $73,626,686 | *$22,092,197* |
| Apples, production (bu.) | 5,512,795 | *11,048,430* |
| Pears, production (bu.) | 420,960 | *378,825* |
| Peaches, production (bu.) | 1,099,735 | *1,023,570* |
| Plums and prunes (bu.) | 84,485 | *295,158* |
| Grapes, production (lbs.) | 42,681,090 | *34,020,198* |
| Forest products, value | $16,587,327 | *$7,986,599* |
| Nurseries: acres 2,774 in 161 establishments; receipts | $1,039,439 | |
| Greenhouses: sq. ft. under glass 16,923,355; receipts | $8,277,124 | |

### 3. Livestock, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock | 188,821; pure breds 22,456 | |
| Value all livestock on farms | $238,774,641 | *$141,480,052* |
| Horses, number | 505,966 | *549,756* |
| value | $60,828,872 | *$68,055,489* |
| Mules, number | 55,081 | *44,323* |
| value | $8,172,057 | *$6,424,039* |
| All cattle, number | 1,545,548 | *1,586,519* |
| value | $123,065,618 | *$47,229,894* |
| Beef cattle, number | 229,745 | |
| Dairy cattle, number | 1,315,803 | *933,664* |
| Sheep, number | 508,711 | *883,074* |
| value | $5,192,704 | *$3,393,144* |
| Goats, number | 2,578 | *3,539* |
| value | $21,567 | *$15,788* |
| Swine, number | 1,190,951 | *977,637* |
| value | $22,111,277 | *$7,624,494* |
| Poultry, number | 15,226,961 | *12,728,341* |
| value | $18,639,535 | *$7,674,387* |
| Bees, number of hives | 122,419 | *124,815* |
| Livestock products, value | $156,012,081 | *$70,159,272* |
| Value all dairy products | $99,617,373 | *$42,808,802* |
| " eggs and chickens | $53,709,243 | *$25,780,701* |
| " wool and mohair | $2,239,021 | *$1,306,965* |
| " honey and wax | $446,444 | *$262,804* |
| Milk produced (gallons) | 421,631,355 | *336,208,572* |
| Butter made (lbs.) | 38,468,607 | *61,158,115* |
| Eggs produced (dozens) | 75,998,172 | *73,683,489* |

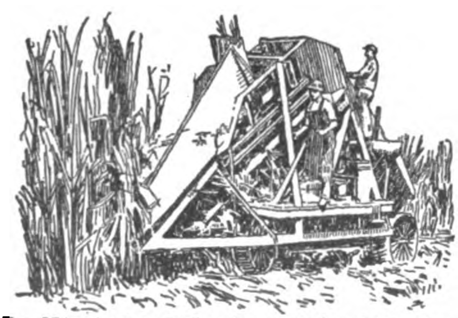


FIG. 374. A triumph of modern agricultural inventive genius—a tractor sugar-cane harvester

# RHODE ISLAND

**RHODE ISLAND** ("Little Rhody"), one of the North Atlantic States, and one of the "original thirteen," lies between 41 and 43 degrees north latitude, and 71 and 72 degrees west longitude. Area, 1,248 square miles, 181 of which are water. It is the smallest and most thickly populated state in the Union.

**Land surface.** This is generally rough and hilly, being dotted with rough knolls. The elevation varies from sea level to 700 or 800 feet at points in the northwest, but in general is below 500 feet. The state is divided into 2 unequal portions by Narragansett Bay; in this are several islands which, with Block Island, 9 miles off the coast, belong to the State. There are a large number of small lakes or "ponds." The principal rivers are the Blackstone in the northeast, the Pawtuxet in the middle (these flowing into arms of the bay) and the Pawcatuck in the southwest flowing into the ocean.

**Soils.** These are of glacial origin, mostly coarse and gravelly, with many boulders and often difficult to cultivate, but they respond readily to fertilizers. In some parts are light loams and small areas of rich bottom land.

**Climate.** Being influenced by the ocean, this is generally equable, though the interior is subject to greater extremes. The highest recorded temperature is 102 degrees, the lowest 9 degrees below zero and the average annual temperature 49 degrees. The frost-free season averages about 190 days; the average annual rainfall is 49 inches, and the average annual snowfall about 36 inches. Severe coast storms sometimes sweep over the state.

**Opportunities.** There are some so-called "abandoned farms," which the State Experiment Station believes afford excellent opportunities for men who have some knowledge of the poultry business, who are in moderate circumstances, and who wish something that gives quick and steady returns. There are many places where the raising of fruits, especially apples, would pay.

**Products and industries.** Only a small part of the population is on farms, and the area of farm land has decreased greatly since early days. Leading farm crops are corn, oats, hay and potatoes. Near the cities, market gardening has been highly developed. In the eastern part, large quantities of onions are grown and early potatoes are a specialty on the Island section. Large areas of glass are used not only for producing winter vegetables and flowers, but also for starting plants for field culture. Apples are the leading tree fruit, closely followed by pears, while peaches succeed fairly well in some seasons. Many cranberries are grown, and there are some fine wild bogs. Strawberries are the leading small fruit. Market-milk production, hay growing and poultry (especially roaster and turkey) production are important in relation to the total agriculture of the state, but like all Rhode Island's farm activities, of small extent compared with those of other typical farming regions. Fisheries are extensive and valuable, oysters being of greatest value. Manufacturing is the main business, no other state approaching Rhode Island in value of manufactured products per capita. Main manufactures are textiles, worsted and cotton goods, foundry and machine-shop products, jewelry, electrical apparatus and supplies, hosiery and knit goods.

**Transportation and markets.** The New York, New Haven and Hartford Railroad with its branches reaches practically all parts of the state; there are, in addition, numerous electric lines, and from the eastern and southern parts, water communication to New York and Boston. Bristol, Providence and Newport are ports of entry. All the manufacturing towns are excellent markets.

**History.** Narragansett Bay was first explored in 1524. Roger Williams founded Providence in 1636, and in 1644 secured a patent of incorporation for the colony, defining the boundaries and granting the colonists "full power and authority to rule themselves." There was frequent dissension among

the different colonies, and much dispute over boundary lines, continued until 1862; but Rhode Island was always a refuge for the oppressed, and was the first to resist English oppression, renouncing its allegiance to the King in 1776. The first successful cotton factory was established at Pawtucket in 1793, and manufacturing soon became the leading industry of the state. Capital, Providence; population, 1910, 224,326.

**Agricultural organization.** Rhode Island State College and Agricultural Experiment Station, *Kingston*. There are the Rhode Island Horticultural Society, Rhode Island Fruit Growers' Association, Rhode Island Beekeepers' Association, Three States Fair Association, Producers' Coöperative Dairy Association, Rhode Island Poultry Association, Rhode Island Corn Growers' Association, Rhode Island Alfalfa Growers' Association, and several Farm Bureau Associations.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Population | 604,397 | *542,610* |
| City | 589,180 (97.5%) | *524,654 (96.7%)* |
| Country | 15,217 (2.5%) | *17,956 (3.3%)* |
| Number of farmers | 4,083 | *5,292* |
| White | 4,063 (99.5%) | *4,251 (99.2%)* |
| Non-white | 20 (.5%) | *41 (.8%)* |
| Land area, acres | 682,880 | |
| Acres in farms | 331,600 | *443,308* |
| Acres farm land improved | 132,855 | *178,344* |
| Av. acres per farm | 81.2 (35.4 impr.) | *83.8 (33.7 impr.)* |
| Acres artificially drained, acres 2,403 (1.8 % imp. farm land) | | |
| Acres needing drainage, acres 8,174 (2.5% all farm land) | | |
| Farms by size, number: | | |
| Up to 19 acres | 936 | *1,377* |
| 20 " 49 " | 983 | *1,144* |
| 50 " 99 " | 1,031 | *1,264* |
| 100 " 174 " | 718 | *954* |
| 175 " 499 " | 357 | *487* |
| Over 500 " | 58 | *75* |
| Value all farm property | $33,636,766 | *$32,990,739* |
| Per cent increase in ten years | 1.9 | *22.5* |
| Value farm land | $14,509,073 | *$15,009,981* |
| " " buildings | $11,878,853 | *$12,922,879* |
| " " implements | $2,408,561 | *$1,781,407* |
| " " livestock | $4,840,279 | *$3,276,472* |
| Av. value all property per farm | $8,238 | *$6,234* |
| " " land and buildings per acre | $79.58 | *$63.01* |
| Farms run by owners | 3,245 (79.5%) | *4,087 (77.2%)* |
| Farms run by tenants | 633 (15.5%) | *954 (18.%)* |
| Per cent owned farms unmortgaged | 60.7 | *68.8* |
| Per cent farms reporting automobiles 29.3; telephones 41.3 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $5,340,378 | *$2,986,816* |
| Value all cereals | $565,745 | *$376,097* |
| Corn, acres | 7,324 | *9,679* |
| production (bu.) | 310,901 | *398,193* |
| 10-yr. av. yield per acre | | 41 bu. |
| Wheat, acres | 106 | *13* |
| production (bu.) | 2,275 | *208* |
| Oats, acres | 1,215 | *1,726* |
| production (bu.) | 34,507 | *48,212* |
| 10-yr. av. yield per acre | | 30.2 bu. |
| Rye, acres | 349 | *477* |
| production (bu.) | 5,650 | *7,545* |
| Hay and forage, acres | 50,490 | *61,326* |
| production (tons) | 90,926 | *80,307* |
| value | $2,319,136 | *$1,309,757* |
| Potatoes, white, acres | 3,149 | *4,649* |
| production (bu.) | 293,087 | *552,677* |
| 10-yr. av. yield per acre | | 118 bu. |
| Small fruits, acres | 246 | *281* |
| production (quarts) | 339,064 | *437,560* |
| Strawberries, acres | 90 | *140* |
| production (quarts) | 116,646 | *326,540* |
| Vegetables, acres 2,163; value | $1,480,326 | *$1,045,093* |
| Apples, production (bu.) | 334,308 | *212,908* |
| Pears, production (bu.) | 10,713 | *12,501* |
| Peaches, production (bu.) | 28,771 | *17,704* |
| Plums and prunes (bu.) | 465 | *1,872* |
| Grapes, production (lbs.) | 400,975 | *152,937* |
| Forest products, value | $470,077 | *$312,022* |
| Nurseries: No. 21; acres 260 receipts | $101,739 | |
| Greenhouses: sq. ft. of glass 2,274,951; receipts | $1,102,063 | |

### 3. Livestock, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock. 3,704; pure breds 367 | | |
| Value all livestock on farms | $4,840,279 | *$3,276,472* |
| Horses, number | 6,540 | *9,547* |
| value | $972,111 | *$1,424,177* |
| Mules, number | 75 | *63* |
| value | $9,037 | *$11,155* |
| All cattle, number | 30,519 | *34,148* |
| value | $2,984,096 | *$1,309,088* |
| Beef cattle, number | 1,706 | |
| Dairy cattle, number | 28,813 | *23,329* |
| Sheep, number | 2,736 | *6,789* |
| value | $37,319 | *$32,637* |
| Goats, number | 116 | *106* |
| value | $1,637 | *$982* |
| Swine, number | 12,869 | 14,038 |
| value | $331,138 | *$123,647* |
| Poultry, number | 266,009 | *415,209* |
| value | $498,257 | *$368,018* |
| Bees, number of hives | 686 | *1,267* |
| Livestock products, value | $5,367,881 | *$3,406,278* |
| Value all dairy products | $3,830,801 | *$2,065,941* |
| " eggs and chickens | $1,526,891 | *$1,330,542* |
| " honey and wax | $1,704 | *$2,959* |
| Milk produced (gallons) | 12,099,111 | *10,441,951* |
| Butter made (lbs.) | 174,902 | *339,606* |
| Eggs produced (dozens) | 1,536,858 | *2,862,247* |

FIG. 375.—Shoot of the true huckleberry


# SOUTH CAROLINA

**SOUTH CAROLINA** ("Palmetto State"), one of the South Atlantic States, lies between 32 and 36 degrees north latitude, and 78 and 84 degrees west longitude. The Savannah, Tugaloo and Chattooga Rivers separate it from Georgia. Area, 30,989 square miles, 494 of which are water.

**Land surface.** The State is mostly in the Coastal Plain and Piedmont Plateau regions in about equal parts, the division extending from northeast to southwest parallel with the coast. The Coastal Plain nowhere exceeds 450 feet above the sea, and is generally level with many swamps along the coast. Northwest of this is the hill country, the elevation gradually rising from about 500 feet to about 1,000 feet, with mountains ranging up to 3,548 feet in Sassafras Mountain on the North Carolina border. The rivers all flow toward the southwest, are rapid, and furnish abundant water power in the hill country. Principal ones are the Waccamaw, the Little and Great Pedee, the Black, the Congaree and Wateree forming the Santee, the Edisto and the Combahee. There are several islands along the coast.

**Soils.** Along the tidewater region are very fertile alluvial soils, some of them needing drainage and protection from overflow. From here to the hills the soils are lighter, sandy and clayey loams. In the hill country, gray sandy surface soils with red clay subsoils, or stiff red clay soils predominate; these are fertile and suited for general farming and fruit growing. The higher parts along the border are wooded and rocky.

**Climate.** This is equable and subtropical along the coast, and cooler and more subject to extremes toward the northwest boundary; the latter is much more healthful. The highest recorded temperature in the eastern part is 107 degrees, and the lowest, 9 degrees below zero, but zero temperatures are rare, and 100 degrees are not common on the coast. The humidity is high during summer. The average frost-free season is about 220 days, varying with the elevation. The average annual rainfall ranges from 43 inches on the lower levels to more than 55 inches in the northwest and is estimated at 60 inches on the North Carolina border. Snowfalls are frequent in winter, but light and of short duration. The State is in the track of the tropical storms that are sometimes destructive along the coast.

**Opportunities.** There are no untaken public lands nor extensive Government drainage or irrigation projects. A number of local cooperative drainage districts have been organized under a state law; in this way, districts in both the Piedmont Section and the Coastal Plain are being drained. In the Coastal Plain are large tracts of cut-over pine lands that may be purchased at reasonable prices. These lands are valuable for grazing, and when properly handled and cultivated, will grow abundant crops of corn, cotton, small grains, truck and tobacco. The counties bordering on the coast, especially around Beaufort and Charleston, have developed an enormous trucking business during the past few years. Large areas of undeveloped land afford excellent opportunities for progressive farmers. Information may be obtained from the Experiment Station at Clemson College.

**Products and industries.** Leading farm activities are the production of cotton, corn, vegetables and fruits for the northern markets, sweet potatoes and yams, and tobacco. Leading livestock are cattle, mules and swine. Dairying and poultrykeeping are increasing in importance. Lumbering is important, 19,000 square miles (most of it cut-over land) being available. Fisheries are considerable, oysters comprising about half the value. The chief mineral is phosphate rock. Manufactures are increasing rapidly, the main ones being cotton goods, in which the state ranks second, lumber and timber products, cottonseed oil and cake, and fertilizers.

**Transportation and markets.** The larger part of the state has railroad communication,

but these roads belong mostly to the main trunk lines. The larger rivers are navigable to some extent half way across the State. Beaufort, Charleston and Georgetown are ports of entry and have good harbors. Charleston is the leading export market, both for foreign and coastwise trade.

History. The Spaniards first visited what is now Port Royal in 1520. In 1562, a party of French Huguenots established a fort at the same place, and named the country Carolina for Charles IX. They abandoned the country the following year. Later the English claimed the territory because of the Cabots' explorations. The first English colony established on the Ashley in 1670; 10 years later it removed to the junction of the Ashley and Cooper rivers and founded Charleston. Agriculture became the leading industry, the colonists prospered, and slavery was apparently profitable. First Negroes imported in 1671. The population increased rapidly to the time of the Revolution. South Carolina was represented at the Continental Congress, and was the first colony to adopt a Provincial Constitution, 1776. During the war of the Revolution, South Carolina contributed more money than any other state except Massachusetts, and more than 100 actions were fought within its borders. The Federal Constitution was adopted in 1788. South Carolina was a leader in the secession movement, the ordinance of secession being passed December 20, 1860. The Bombardment of Fort Sumter in Charleston Harbor, April 12, 1861, opened the Civil War, and the evacuation of Charleston in February, 1865, was one of its closing events. The State was readmitted to the Union in 1868. On August 31, 1886, Charleston was visited by a destructive earthquake. Capital, Columbia; popuation, 1910, 26,319.

Agricultural organization. Clemson Agricultural College and Experiment Station, both *Clemson College*. Sub-stations, *Florence* and *Summerville*. The Colored Normal, Industrial, Agricultural and Mechanical College of South Carolina, *Orangeburg*. State Agricultural and Mechanical Society, *Columbia*. South Carolina Live Stock Association; South Carolina Plant Breeders' Association. State Fair is held at *Columbia*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | | |
|---|---|---|
| Population | 1,683,724; | *1,515,400* |
| City | 293,987 (17.5%); | *224,832 (14.8%)* |
| Country | 1,389,737 (82.5%); | *1,290,568 (85.2%)* |
| Number of farmers | 192,693; | *176,434* |
| White | 83,683 (43.4%); | *79,636 (45.1%)* |
| Non-white | 109,010 (56.6%); | *96,798 (54.9%)* |
| Land area, acres | 19,516,800 | |
| Acres in farms | 12,426,765; | *13,512,028* |
| Acres farm land improved | 6,184,159; | *6,097,999* |
| Average acres per farm | 64.4 (32 impr.); | *76.6* (*34.6* impr.) |
| Farm land artifi: drained, acres | 676,152 (10.9% impr. farm land) | |
| Farm land needing drainage, acres | 1,341,903 (10.8% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 40,825; | *37,985* |
| 20 " 49 " | 84,893; | *70,582* |
| 50 " 99 " | 37,530; | *33,147* |
| 100 " 174 " | 18,166; | *19,427* |
| 175 " 499 " | 9,352; | *12,539* |
| Over 500 " | 1,927; | *2,754* |
| Value all farm property | $953,064,742; | *$392,128,314* |
| Per cent increase in ten years | 143; | *155.3* |
| Value farm land | $647,157,209; | *$268,774,854* |
| " " buildings | $166,326,991; | *$64,113,227* |
| " " implements | $48,062,387; | *$14,108,853* |
| " " livestock | $91,518,155; | *$45,131,380* |
| Av. value all property per farm | $4,946; | *$2,223* |
| " " land and buildings per acre | $65.46; | *$24.64* |
| Number farms run by owners | 67,724 (35.1%); | *64,350* (*36.4%*) |
| Number farms run by tenants | 124,231 (64.5%); | *111,221* (*63.%*) |
| Per cent owned farms unmortgaged | 63.3; | *73.9* |
| Per cent farms reporting automobiles 15.9; telephones 5.7 | | |

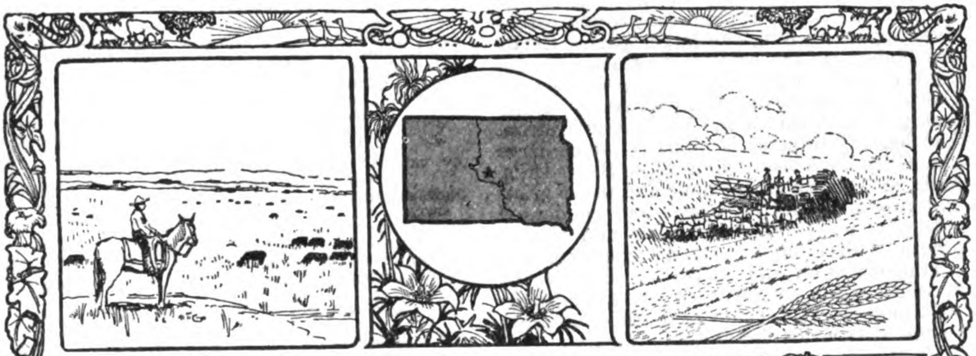
### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $437,121,837; | *$137,379,131* |
| " " cereals | $61,401,182; | *$25,434,539* |
| Corn, acres | 1,753,813; | *1,565,832* |
| production (bu.) | 27,472,013; | *20,871,946* |
| 10-yr. av. yield per acre | | 17.7 bu. |
| Wheat, acres | 84,621; | *43,028* |
| production (bu.) | 630,911; | *310,614* |
| 10-yr. av. yield per acre | | 10.9 bu. |
| Oats, acres | 196,056; | *324,180* |
| production (bu.) | 3,597,835; | *5,745,291* |
| 10-yr. av. yield per acre | | 20.6 bu. |
| Rye, acres | 6,877; | *2,958* |
| production (bu.) | 50,342; | *20,631* |
| 10-yr. av. yield per acre | | 10.4 bu. |
| Cotton, acres | 2,631,719; | *2,556,467* |
| production (bales) | 1,476,645; | *1,279,866* |
| 10-yr. av. yield per acre | | 231 lbs. |
| Hay and forage, acres | 668,538; | *209,767* |
| production (tons) | 400,343; | *186,131* |
| value | $11,778,637; | *$3,243,835* |
| Tobacco, acres | 103,496; | *30,082* |
| production (lbs.) | 71,193,072; | *25,583,049* |
| 10-yr. av. yield per acre | | 690 lbs. |
| Potatoes, white, acres | 13,402; | *8,610* |
| production (bu.) | 1,077,936; | *782,430* |
| 10-yr. av. yield per acre | | 85 bu. |
| sweet, acres | 60,325; | *48,878* |
| production (bu.) | 5,369,611; | *4,319,926* |
| 10-yr. av. yield per acre | | 94 bu. |
| Peanuts, acres | 7,460; | *7,596* |
| production (bu.) | 112,578; | *154,822* |
| Sugar cane, acres | 5,537; | *7,053* |
| production (tons) | 34,947; | *59,865* |
| Sorghum, acres | 20,431; | *6,131* |
| production (tons) | 69,865; | *22,371* |
| Rice, acres | 6,547; | *19,491* |
| production (bu.) | 122,465; | *541,579* |
| Small fruits, acres | 498; | *850* |
| production (quarts) | 269,248; | *1,408,096* |
| Strawberries, acres | 312; | *815* |
| production (quarts) | 223,745; | *1,157,472* |
| Vegetables, acres 15,978; value | $23,374,542; | *$6,922,021* |
| Apples, production (bu.) | 215,659; | *362,800* |
| Pears, production (bu.) | 98,975; | *65,680* |
| Peaches, production (bu.) | 389,734; | *643,040* |
| Plums and prunes (bu.) | 35,891; | *48,754* |
| Grapes, production (lbs.) | 2,668,650; | *2,016,506* |
| Forest products, value | $12,256,764; | *$4,513,092* |
| Nurseries: No.18; acres 315 receipts | | $106,871 |
| Greenhouses: sq. ft. of glass 204,913; receipts | | $140,178 |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Farms reporting livestock | 181,452; | pure breds. 6,188 |
| Value all livestock on farms | $91,518,155; | *$45,131,380* |
| Horses, number | 77,517; | *79,847* |
| value | $11,442,492; | *$10,147,178* |
| Mules, number | 220,164; | *155,417* |
| value | $44,499,036; | *$23,830,361* |
| All cattle, number | 434,097; | *389,882* |

| | | |
|---|---|---|
| All cattle, value | $20,187,834; | *$7,088,259* |
| Beef cattle, number | 117,603; | |
| Dairy cattle, number | 316,494; | *180,842* |
| Sheep, number | 23,581; | *37,559* |
| value | $109,131; | *$81,362* |
| Goats, number | 31,774; | *24,750* |
| value | $93,463; | *$27,728* |
| Swine, number | 844,981; | *665,211* |
| value | $10,710,642; | *$* |
| Poultry, number | 4,240,009; | *2,946,414* |
| Poultry, value | $4,263,068; | *$1,206,615* |
| Bees, number of hives | 58,028; | *75,432* |
| Livestock products, value | $20,354,060; | *$7,611,077* |
| Value all dairy products | $7,995,753; | *$2,800,605* |
| " eggs and chickens | $12,204,752; | *$4,710,976* |
| " wool and mohair | $36,117; | *$20,656* |
| " honey and wax | $117,438; | *$78,930* |
| Milk produced (gallons) | 52,954,637; | *37,361,666* |
| Butter made (lbs.) | 30,257,153; | *27,246,247* |
| Eggs produced (dozens) | 12,812,143; | *10,983,171* |



# SOUTH DAKOTA

**SOUTH DAKOTA** ("Coyote State"), one of the North Central States, lies between 42 and 46 degrees north latitude, and 96 and 105 degrees west longitude. The Big Sioux and Missouri Rivers form part of the boundary on the southeast, and Lake Traverse and Big Stone Lake on the northeast. Area, 77,615 square miles, 747 of which are water.

**Land surface.** The Missouri River, crossing the state in a southerly direction, divides it into two parts. To the east, it is largely a gently rolling plain, treeless except along the streams, and diversified by a number of small lakes. The average elevation is about 1,500 feet above sea level. The James and Big Sioux Rivers flow south through this region into the Missouri River, their valleys being separated by higher divides. West of the Missouri, the surface is a rough, rolling tableland, and toward the western boundary is mountainous in the Black Hills region. The elevations range from about 1,500 feet at the Missouri River, to about 3,200 feet on the border of the Hills which are 6,000 to 8,000 feet high at some points. The hills are generally wooded, with fertile valleys and swiftly flowing streams which are fed by springs. The Missouri River drains this region, the chief tributaries on the west being the Grand, Moreau, or Owl, Cheyenne, Bad and White Rivers.

**Soils.** These are largely from a glacial till, in some places of great depth, and brown or yellow silt loams; in the southeastern part, loess is found forming brown silty loams of great fertility. In the river valleys, very fertile alluvial soils are found. West of the Missouri River, the soils are sandy loams, clay loams and heavy clays better suited for grazing than for tillage. In the Black Hills region, the narrow valleys are very fertile, and suited for general farming and fruit growing.

**Climate.** This is subject to sudden and extreme changes of temperature. The extreme dryness of the atmosphere makes the low temperatures seem less severe. Highest recorded temperature in the eastern part is 114 degrees; lowest, 46 degrees below zero. The average annual temperature is 44.5 degrees. The average frost-free season is about 130 days, longer in the south. The average annual rainfall is about 22 inches, the larger part during the growing season. The average annual snowfall is less than 30 inches. The state is subject to very high winds. In the western section, the highest recorded temperature is 115 degrees; the lowest, 44 degrees below zero. The average annual temperature is about 45.6 degrees. Average frost-free season about 130 days. Average annual snowfall about 38 inches. Average annual rainfall is about 17.3 inches, largely during the growing season. It is greatest in the more elevated Hills region, decreasing from south to north. Hailstorms sometimes occur. The Chinook winds sometimes modify the temperature in the northwest.

**Opportunities.** There are a number of irrigation projects, some conducted by the U. S. Reclamation Service, and others by coöperative and other enterprises. Information about the former may be obtained from the U. S.

Reclamation Service, Washington, D. C., and about other lands from the Board of Agriculture, Huron, or the Agricultural Experiment Station, Brookings.

**Products and industries.** South Dakota has developed rapidly in general agriculture, especially in the eastern section. Leading farm crops are wheat, corn in the southern part, oats, barley, emmer and spelt, flaxseed, potatoes and hay. General farming is the rule in the east. Fruit growing is not extensive, apples forming the larger part. Cattle and horses are the leading livestock, this being the great industry in the western section. Dairying is increasing in importance. Lumbering is confined to the Black Hills region. The leading mineral is gold, of which large quantities have been found in the Black Hills. Main manufactures are flour and other gristmill products; butter, cheese and condensed milk; bakery products; lumber and timber products; all closely connected with agriculture.

**Transportation and markets.** East of the Missouri and in the southwest corner, railroads are numerous. Water transportation is afforded by the Missouri River and its branches.

**History.** South Dakota was a part of the Louisiana Purchase. It was visited by the Lewis and Clark expedition 1804–6. Fort Pierre was founded 1829. In 1838–9 General Fremont made extensive explorations in the eastern and central parts. Sioux Falls, the first industrial settlement, was founded in 1857. The part east of the Missouri River had been successively included in Michigan Territory in 1834; Wisconsin in 1836; Iowa in 1838; Minnesota in 1849; and the part west of the Missouri in Nebraska Territory in 1854. Dakota Territory was organized March 2, 1861. The Territorial Capital was located at Yankton in 1862, but was removed to Bismarck in 1883. The discovery of gold in 1874 hastened the development of the Black Hills regions. The territory was divided in 1889, and the same year, November 3, South Dakota was admitted as a state. Capital, Pierre, population, 1910, 3,656.

**Agricultural organization.** College of Agriculture and Mechanic Arts, Experiment Station, *Brookings*; sub-stations, *Eureka, Highmore, Cottonwood, Vivian.* Board of Agriculture. *Huron.* Corn Growers' Association, *Fulton.* Improved Live Stock and Poultry Association, Horticultural Society, Dairymen's Association, all *Brookings*; Live Stock Sanitary Board, *Pierre.* There are also a Game and Fish Commission and a State Grange.

### Statistics

#### 1. Farms and Farm Property, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Population | 636,547 | *583,888* |
| City | 101,872 (16%) | *76,673 (14%)* |
| Country | 534,675 (84%) | *507,215 (86%)* |
| Number of farmers | 74,637 | *77,644* |
| White | 73,025 (97.8%) | *74,836 (96.4%)* |
| Non-white | 1,612 (2.2%) | *2,808 (3.6%)* |
| Land area, acres | 49,195,520 | |
| Acres in farms | 34,636,491 | *26,016,892* |
| Acres farm land improved | 18,199,250 | *15,827,208* |
| Average acres per farm | 466.7 (243.8 impr.) | *335 (203.8* impr.) |
| Farm land artificially drained, acres | 161,371 (.9% impr. farm land) | |
| Farm land needing drainage, acres | 446,915 (1.3% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 766 | *808* |
| 20 " 49 " | 993 | *1,121* |
| 50 " 99 " | 2,381 | *2,406* |
| 100 " 174 " | 16,463 | *28,396* |
| 175 " 499 " | 37,343 | *33,041* |
| Over 500 " | 16,691 | *11,872* |
| Value all farm property | $2,823,870,212 | *$1,166,096,980* |
| Per cent increase in ten years | 140.4 | *291.9* |
| Value farm land | $2,231,431,723 | *$902,606,751* |
| " " buildings | $241,461,958 | *$102,474,056* |
| " " implements | $112,408,268 | *$33,786,973* |
| " " livestock | $238,568,263 | *$127,229,200* |
| Av. value all property per farm | $4,946 | *$2,223* |
| " " land and buildings per acre | $71.40 | *$38.63* |
| Number farms run by owners | 47,815 (64%) | *57,984 (74.6%)* |
| Number farms run by tenants | 26,041 (34.9%) | *19,231 (24.8%)* |
| Per cent owned farms unmortgaged | 33.5 | *60.5* |
| Per cent farms reporting automobiles 69.4, telephones 59.4 | | |

#### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | 1919 | *1909* |
|---|---|---|
| Value all farm crops | $311,006,809 | *$125,116,080* |
| " " cereals | $220,890,085 | *$98,953,050* |
| Corn, acres | 2,756,234 | *2,037,658* |
| production (bu.) | 69,060,782 | *55,558,737* |
| 10-yr. av. yield per acre | | 28.2 bu. |
| Wheat, acres | 3,891,468 | *3,217,255* |
| production (bu.) | 31,086,995 | *47,685,745* |
| 10-yr. av. yield per acre | | 11 bu. |
| Oats, acres | 1,839,089 | *1,558,643* |
| production (bu.) | 51,091,904 | *43,565,676* |
| 10-yr. av. yield per acre | | 30.4 bu. |
| Rye, acres | 463,132 | *13,778* |
| production (bu.) | 4,111,543 | *194,672* |
| 10-yr. av. yield per acre | | 15.8 bu. |
| Barley, acres | 754,929 | *1,114,531* |
| production (bu.) | 12,815,768 | *22,396,130* |
| 10-yr. av. yield per acre | | 23 bu. |
| Hay and forage, acres | 5,071,747 | *3,435,656* |
| production (tons) | 4,996,846 | *3,651,024* |
| Value | $71,988,845 | *$15,247,570* |
| Potatoes, white, acres | 58,180 | *50,052* |
| production (bu.) | 2,863,186 | *3,441,692* |
| 10-yr. av. yield per acre | | 86 bu. |
| Buckwheat, acres | 3,356 | *1,904* |
| production (bu.) | 28,825 | *28,551* |
| Flax, acres (1920) | 220,000 | *518,566* |
| production (bu.) | 2,200,000 | *4,759,794* |
| value | $3,630,000 | |
| Small fruits, acres | 412 | *419* |
| production (quarts) | 224,398 | *401,295* |
| Strawberries, acres | 227 | *226* |
| production (quarts) | 141,163 | *238,164* |
| Vegetables, acres 2,397; value | $10,700,773 | *$3,001,574* |
| Apples, production (bu.) | 168,256 | *191,784* |
| Pears, production (bu.) | 43 | *162* |
| Peaches, production (bu.) | 21 | *148* |
| Plums and prunes, (bu.) | 11,861 | *31,748* |
| Grapes, production (lbs.) | 24,209 | *144,634* |
| Forest products, value | $238,462 | *$257,126* |
| Nurseries: acres 475 in 10 establishments; receipts | $212,101 | |
| Greenhouses: sq. ft. under glass 224,444; receipts | $214,726 | |

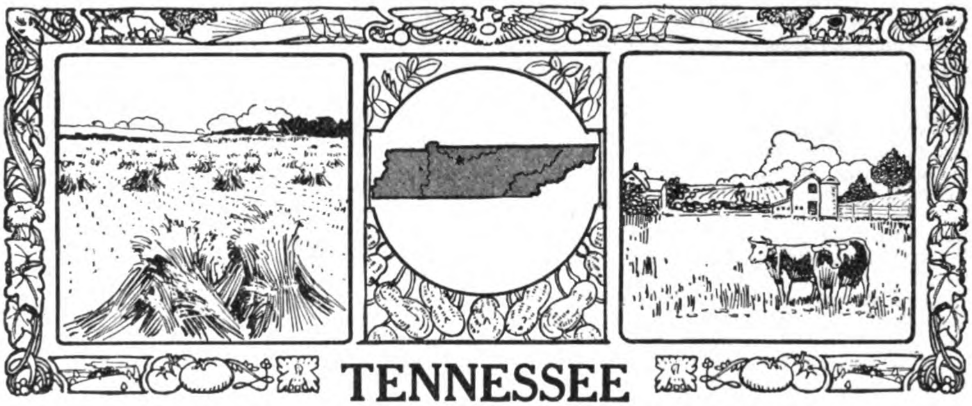
#### 3. Livestock, 1920 and *1910*

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock | 73,203; pure breds 23,286 | |
| Value all livestock on farms | $238,568,263 | *$127,229,200* |
| Horses, number | 817,058 | *669,362* |
| value | $57,051,132 | *$73,442,978* |
| Mules, number | 15,093 | *12,424* |
| value | $1,636,376 | *$1,668,617* |

| | | |
|---|---|---|
| All cattle, number | 2,348,157; | *1,635,276* |
| value | $119,980,683; | *$36,257,234* |
| Beef cattle, number | 1,801,899; | |
| Dairy cattle, number | 546,258; | *369,764* |
| Sheep, number | 843,696; | *611,264* |
| value | $10,635,258; | *$3,002,038* |
| Goats, number | 1,286; | *1,074* |
| value | $7,949; | *$11,422* |
| Swine, number | 1,953,826; | *1,009,721* |
| value | $42,997,699; | *$10,387,093* |
| Poultry, number | 6,968,088; | *5,251,348* |
| value | $6,126,335; | *$2,356,465* |
| Bees, number of hives | 11,114; | *6,565* |
| Livestock products, value | $35,739,209; | *$13,660,311* |
| Value all dairy products | $16,812,347; | *$6,192,608* |
| " eggs and chickens | $16,050,023; | *$6,599,858* |
| " wool and mohair | $2,761,265; | *$847,402* |
| " honey and wax | $115,574; | *$20,443* |
| Milk produced (gals.) | 124,424,918; | *82,428,514* |
| Butter made (lbs.) | 10,267,171; | *13,629,647* |
| Eggs produced (dozens) | 30,351,984; | *24,641,342* |

**4. Irrigation, 1920 and *1910***

| | | |
|---|---|---|
| Acres in irrigated projects | 188,382; | *201,625* |
| " of projects irrigable | 150,914; | *128,481* |
| " " " irrigated | 100,682; | *63,248* |
| " " irrigated land open to settlement | | |
| Capital invested in projects | $5,465,248; | *$3,043,140* |
| Average investment, per acre | $36.21; | *$23.69* |
| Estimated final cost | $5,500,748; | *$3,800.556* |
| Average cost per acre | $29.20; | *$18.85* |
| " " maintenance and operation, per acre | $1.26; | *$0.64* |
| Acres of crops on irrigated land | 67,021 | |
| Value of crops on irrigated land | $2,403,548 | |
| Av. value crops on irrigated land, per acre (1919) | $35.86 | |



# TENNESSEE

**TENNESSEE** ("Big Bend State"), one of the South Central States, lies between 35 and 37 degrees north latitude, and 81 and 91 degrees west longitude. The Mississippi River forms the entire western boundary. Area, 42,022 square miles, 335 of which are water.

**Land surface.** This is greatly diversified. The Great Smoky Mountains extend northeast to southwest across the eastern part, with an average elevation of 5,000 feet and some peaks of 6,000 feet. Next is the Valley of East Tennessee extending across the State parallel with the mountains at an average elevation of 1,000 feet and comprising 9,000 square miles. Next comes the Cumberland Tableland or Plateau, about 2,000 feet high and 50 miles wide with a surface area of about 5,000 square miles. The Central Basin is lower, with an average elevation of about 500 feet. Surrounding the Basin is the Highland Rim with an elevation of about 1,000 feet; next comes the western valley of the Tennessee, about 370 feet and the plateau of West Tennessee rising to about 700 feet and then sloping to the Mississippi and ending in a line of bluffs about 350 feet above sea level. The Tennessee River, formed by a union of the Holston and Clinch in the eastern part, flows south into Alabama and reenters Tennessee in the western part, and flows north entirely across the state into Kentucky. The Cumberland enters the State from Kentucky, makes a detour through the northern part and returns to Kentucky. Both flow into the Ohio. Numerous small rivers flow into these and into the Mississippi on the west.

**Soils.** These are as varied as the surface, but are mostly fertile. In the mountain region the soil of the valleys is fertile, the mountains are forested and grass grows along their summits. In the Tennessee River Valleys fertile loams predominate. Thin loams predominate on the Cumberland Plateau. On the Highland Rim are fertile red soils, the gray soils being poor as a rule. The Central Basin has fertile loams with bluegrass lands and phosphate deposits and is the richest agricultural region. The western slope has silt soils adapted to a wide range of crops, and the Mississippi River bottoms the richest almost inexhaustible alluvial soils.

**Climate.** This is considered very healthful, sudden and extreme changes of temperatures being rare. The average annual temperature for the state is 58 degrees, higher in the valleys, lower in the mountains. The highest recorded temperature is 107 degrees;

the lowest, 30 degrees below zero, but these extremes are rare. Average frost-free season is about 180 days, varying according to elevation. The average annual rainfall is about 50 inches. The average annual snowfall is about 10 inches. Tennessee lies outside the principal storm tracks so is not subject to severe storms.

**Opportunities.** There are large areas of undeveloped lands especially on the Highland Rim and the Cumberland Plateau. The State laws are favorable to drainage projects as approved by the county courts. In this way large areas are being reclaimed in West Tennessee. Information about lands for settlers may be obtained from the State Department of Agriculture, Nashville.

**Products and industries.** The diversified surface, the different elevations, the great variety of soil, the abundant rainfall and favorable climate insure a wide range of agricultural products. The leading farm crops are corn, wheat, oats, cowpeas, soy beans, peanuts, hay, cotton, tobacco and potatoes. Large quantities of vegetables are grown for market. Most small fruits are indigenous to the State. Apples and peaches are the leading tree fruits, and grapes thrive in all locations. The leading livestock are horses, mules, cattle and hogs. Dairying is an important and growing industry, while poultry exceeds in value the sheep. Lumbering is one of the most important industries, forests of hard wood being extensive. The fisheries are not extensive. Coal is the leading mineral; copper, iron ore, phosphate, marble and zinc are important. Main manufactures are lumber and timber products, flour and grist-mill products, foundry and machine-shop products, railroad shop construction, cottonseed oil and cake, cotton goods, iron and steel, hosiery and knit goods.

**Transportation and markets.** Transportation facilities are good, Memphis being a railroad center, and a number of trunk lines crossing the state. The Mississippi, Tennessee and Cumberland Rivers furnish abundant water communication. The larger market cities are Memphis, Nashville, Chattanooga and Knoxville.

**History.** De Soto reached the present site of Memphis in April, 1541. French explorers descended the Mississippi River in 1673, erected Fort Prud'Homme in 1682, and a trading post near Nashville in 1714. The English established Fort London in 1756. A series of permanent settlements were begun in 1769 on the Wautauga and Holston Rivers by colonists from Virginia and North Carolina. Tennessee was made a part of North Carolina and was known as the County of Washington. It was ceded by North Carolina to the Federal Government in 1784, receded in 1790. The first Territorial legislature met in 1794, a constitutional convention was held in 1796, and on June 1 of that year Tennessee became a state. A secession ordinance was adopted by popular vote, June, 1861. Next to Virginia, Tennessee was the principal battle ground of the Civil War. It was readmitted to the Union, July 24, 1866. Capital, Nashville; population, 1910, 110,364.

**Agricultural organization.** College of Agriculture and Experiment Station, *Knoxville;* West Tennessee sub-station, *Jackson;* Middle Tennessee sub-station, *Columbia.* Cooperative Demonstration Work, Eastern Tennessee, *Washington, D. C.;* Western Tennessee, *Birmingham, Alabama.* State Fair Board, *Nashville;* Tri-State Fair Board, *Memphis.* Nashville, Knoxville and Memphis each has a division fair partly supported by the state. State Department of Agriculture, *Nashville.* There are Farmers' Institute Boards for the middle, eastern and western sections; Farmers' Union, Nurserymen's Association, and Highway Association.

The Experiment Station Director reports that agricultural conditions are improving; that better methods of farming are followed than formerly; that purebred livestock is on the increase; and that there appears to be no reason why Tennessee should not become a prominent livestock state.

### Statistics

#### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 2,337,885; *2,184,789* |
| City | 611,226 (26.1%); *441,045 (20.2%)* |
| Country | 1,726,659 (73.9%); *1,743,744 (79.8%)* |
| Number of farmers | 252,774; *246,012* |
| White | 214,592 (84.9%); *207,704 (84.4%)* |
| Non-white | 38,182 (15.1%); *38,308 (15.6%)* |
| Land area, acres | 26,679,680 |
| Acres in farms | 19,510,856; *20,041,657* |
| Acres farm land improved | 11,185,302; *10,890,484* |
| Av. acres per farm | 77.1 (44 impr.); *81.5 (44 impr.)* |
| Farm land artificially drained, acres | 254,118 (2.3% impr. farm land) |
| Farm land needing drainage, acres | 640,479 (3.3% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 44,528; *47,341* |
| 20 " 49 " | 79,924; *72,212* |
| 50 " 99 " | 64,940; *60,105* |
| 100 " 174 " | 41,283; *41,545* |
| 175 " 499 " | 20,172; *22,450* |
| Over 500 " | 1,927; *2,359* |
| Value all farm property | $1,251,964,585; *$612,520,836* |
| Per cent increase in ten years | 104; *79.5* |
| Value farm land | $807,782,296; *$371,415,783* |
| " " buildings | $217,197,598; *$109.106,804* |
| " " implements | $53,462,556; *$21,292,171* |
| " " livestock | $173,522,135; *$110,706,078* |
| Av. value all property per farm | $4,953; *$2,490* |
| " " land and buildings per acre | $52.53; *$23.98* |
| Number farms run by owners | 148,082 (58.5%); *144,125 (58.5%)* |
| Number farms run by tenants | 103,885 (41.1%); *101,061 (41.1%)* |
| Per cent owned farms unmortgaged | 71; *82.1* |
| Per cent farms reporting automobiles 8.9; telephones 22.5 | |

#### 2. Crop Acreages, Yields, Values, 1919 and *1909*

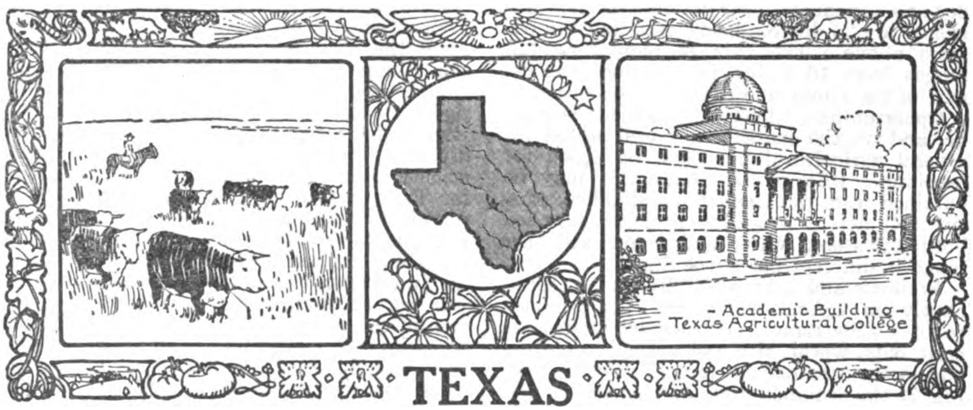
| | | |
|---|---|---|
| Value all farm crops | $318,285,307; | *$111,133,210* |
| " " cereals | $144,778,157; | *$55,302,278* |
| Corn, acres | 3,301,075; | *3,146,348* |
| production (bu.) | 70,639,253; | *67,682,489* |
| 10-yr. av. yield per acre | | 25.3 bu. |
| Wheat, acres | 684,497; | *619,861* |

| | | |
|---|---|---|
| Wheat, production (bu.).... | 6,362,357; | *6,516,539* |
| 10-yr. av. yield per acre............. | | 10.8 bu. |
| Oats, acres.............. | 162,417; | *342,086* |
| production (bu.).... | 2,413,409; | *4,720,692* |
| 10-yr. av. yield per acre............. | | 22.6 bu. |
| Rye, acres.............. | 28,326; | *22,798* |
| production (bu.).... | 171,124; | *140,925* |
| 10-yr. av. yield per acre............. | | 10.8 bu. |
| Cotton, acres............ | 807,770; | *787,516* |
| production (bales).. | 306,974; | *264,562* |
| 10-yr. av. yield per acre............. | | 191 lbs. |
| Hay and forage, acres....... | 1,751,123; | *1,052,816* |
| production (tons)... | 1,907,345; | *1,077,836* |
| value............. | $49,649,657; | *$12,784,783* |
| Buckwheat, acres........... | 3,532; | *2,867* |
| production (bu.).... | 46,032; | *33,249* |
| 10-yr. av. yield per acre............. | | 17.8 bu. |
| Potatoes, white, acres....... | 29,873; | *40,963* |
| production (bu.).... | 1,990,951; | *2,922,713* |
| 10-yr. av. yield per acre............. | | 72 bu. |
| sweet, acres.............. | 39,645; | *26,216* |
| production (bu.).... | 4,452,883; | *2,504,490* |
| 10-yr. av. yield per acre............. | | 96 bu. |
| Peanuts, acres............. | 8,132; | *18,952* |
| production (bu.).... | 264,483; | *547,240* |
| Tobacco, acres............. | 138,561; | *90,468* |
| production (lbs.).... | 112,367,567; | *68,756,599* |
| 10-yr. av. yield per acre............. | | 771 lbs. |
| Sorghum, acres............ | 49,131; | *45,410* |
| production (tons)... | 148,689; | *183,328* |
| Barley, acres.............. | 5,894; | *2,567* |
| production (bu.).... | 96,173; | *53,201* |
| 10-yr. av. yield per acre............. | | 23.9 bu. |
| Small fruits, acres.......... | 12,544; | *12,539* |
| production (quarts). | 14,620,175; | *13,895,493* |
| Strawberries, acres.......... | 10,876; | *10,761* |
| production (quarts). | 13,130,904; | *12,339,584* |
| Vegetables, acres 20,877: value | $27,847,250; | *$10,430,975* |

| | | |
|---|---|---|
| Apples, production (bu.)..... | 1,258,878; | *4,640,444* |
| Pears, production (bu.)...... | 114,963; | *83,557* |
| Peaches, production (bu.).... | 1,285,441; | *1,579,019* |
| Plums and prunes (bu.)...... | 70,103; | *139,093* |
| Grapes, production (lbs.).... | 1,839,450; | *1,979,480* |
| Forest products, value....... | $20,868,262; | *$8,510,710* |
| Nurseries: no. 109; acres 1,168; receipts........ | | $666,028 |
| Greenhouses: sq. ft. of glass 1,245,312; receipts, | | $626,923 |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Farms reporting livestock.... | 242,630; | pure breds 15,800 |
| Value all livestock on farms.. | $173,522,135; | *$110,706,078* |
| Horses, number........... | 317,921; | *349,709* |
| value............. | $35,582,960; | *$29,320,044* |
| Mules, number........... | 352,510; | *275,855* |
| value............. | $51,042,649; | *$35,100,810* |
| All cattle, number......... | 1,161,846; | *996,529* |
| value............. | $51,370,208; | *$20,690,718* |
| Beef cattle, number..... | 492.486; | |
| Dairy cattle, number.... | 669,360; | *397,104* |
| Sheep, number........... | 364,196; | *795,033* |
| value............. | $4,021,678; | *$3,009,196* |
| Goats, number........... | 73,228; | *43,560* |
| value............. | $246,560; | *$82,666* |
| Swine, number........... | 1,832,307; | *$1,378,938* |
| value............. | $19,477,775; | *$7,329,622* |
| Poultry, number.......... | 11,835,303; | *8,056,145* |
| value............. | $10,591,690; | *$3,757,337* |
| Bees, number of hives..... | 191,898; | *144,481* |
| Livestock products, value.... | $50,960,694; | *$22,398,336* |
| Value all dairy products... | $20,640,849; | *$8,715,441* |
| " eggs and chickens... | $29,065,336; | *$13,032,321* |
| " wool and mohair.... | $733,980; | *$467,512* |
| " honey and wax..... | $520,529; | *$183,062* |
| Milk produced (gallons)... | 130,285,644; | *117,101,970* |
| Butter made (lbs.)........ | 37,166,063; | *39,827,906* |
| Eggs produced (dozens).... | 48-707,146; | *1,244.285* |




**TEXAS** ("Lone Star State"), one of the South Central States, lies between 25 and 37 degrees north latitude, 93 and 107 degrees west longitude. The Red River on the north, the Sabine River on the east, and the Rio Grande on the southwest form a considerable part of its boundaries. Its extreme dimensions are 780 miles from east to west and 750 miles from north to south. Area, 265,896 square miles, 3,498 of which are water. It far exceeds any other State in area.

**Land surface.** Along the coast this is low, and fringed with numerous low, sandy islands with shallow sounds or bays. Next comes the prairie belt about 150 miles in width, of an undulating surface with extensive belts of forest. Beyond this is the Great Plains region, with a more broken surface, less timber and other vegetable growth than the prairies, and a higher altitude. In the northwest is the Llano Estacado or Staked Plain, a semi-arid plateau, 2,000 to 4,500 feet elevation. West of the Pecos River, it is mountainous, spurs of the Rocky Mountains rising to a general elevation of more than 2,000 feet and to 5,000 to 6,000 feet in several mesas. Numerous rivers all flow toward the southeast except the Canadian, which flows east across the extreme northern part. The largest are the Neches, Trinity, Brazos, Colorado, San Antonio and Nueces.

Soils. Along the coast these are sandy; in

the prairie region, they are a mixture of sand and clay with considerable humus; farther north and west are limestone and clay soils; in the great forest region of eastern Texas and extending to the west along the Red River Valley are sandy soils underlaid with red and yellow clay; in the north are loam soils often mixed with clay, which becomes very sticky when wet. Nearly all can be profitably cultivated.

**Climate.** Along the coast, the temperature averages high, but without great variations. Galveston is typical, with a highest recorded temperature of 98 degrees; lowest, 8 degrees, average annual temperature 69.8 degrees. The frost-free season here usually covers all but parts of December and January, and some seasons there are no killing frosts. The average annual rainfall is about 47 inches. Hurricanes are liable to occur during the late summer and early autumn months. In the interior there are greater variations. In central Texas, extremes of from 116 above to 12 degrees below zero have been recorded, and average annual temperatures of 62.9 to 67.7 degrees. The average annual rainfall varies from about 20 inches in the western part to 33 inches in the eastern; snowfall is light. The frost-free season usually covers about 8 months. The northern part is subject to sudden and extreme changes in temperature. Extremes are 23 degrees below zero and 116 degrees above. The average annual rainfall ranges from 16 inches in the northwestern part of the Panhandle to 30 in the southeast.

**Opportunities.** There is considerable public land on the market, not well suited for general agricultural purposes, but good for ranching. Information about this may be obtained from the General Land Office, Austin. Numerous irrigation projects, supplied both by stored water and from wells, are found in different parts the State.

**Products and industries.** Texas is preëminently an agricultural state. Its products cover a wide range. The leading grains are corn, oats, wheat, rice and barley. Potatoes and sweet potatoes are largely grown. Cotton is the leading crop, and sugar cane is raised in limited areas in the Brazos, Colorado and Rio Grande Valleys. Rice is grown extensively under irrigation in the southeastern part. Fruit growing is extensive in the eastern part of the state. Peaches are grown on sandy or sandy loam soils throughout the state. Apples are grown in a limited way. Grapes are adapted but not grown extensively. Dewberries and blackberries are well adapted. Strawberries lead among the small fruits. Among citrus fruits, the Satsuma orange and the grapefruit are reasonably well adapted, but frequently suffer from frost. Truck farming is carried on extensively in the Rio Grande Valley, the Gulf Coastal Plain, certain parts of eastern Texas, and in the territory adjacent to the towns and cities of any importance. The leading livestock are cattle, horses, mules, swine, sheep and Angora goats. More mules are raised than in any other state, and Texas is the greatest mohair-producing state in the Union. The number of dairy cows has increased largely. The value of poultry products exceeds that of dairy products. Lumbering is an important industry, about one fourth of the state being wooded. The great forest region of eastern Texas is said to be one of the richest forests in America. Fisheries are unimportant. The principal minerals are petroleum and coal. Main manufactures are flour and grist-mill products, cottonseed oil and cake, lumber and timber products, meat products, cars and railroad construction, petroleum refining, foundry and machine-shop products. Leading manufacturing towns are Dallas, Houston, San Antonio and Fort Worth.

**Transportation and markets.** The eastern part is well covered with railroads, the rest of the state fairly well. Dallas, Fort Worth and Houston are important railroad centers and markets. Galveston, the only port of entry, is first among southern ports in value of exports, and is exceeded by New York City alone. Cotton is the leading export.

**History.** The first explorers were Spaniards from Mexico during the sixteenth century. After the Louisiana Purchase, 1803, American colonists came in large numbers, and trouble over the boundary resulted in Spain's rights to the territory as far as the Sabine River being recognized. Texas, with two other divisions, was made a separate state; a revolt ensued, then open warfare, and final victory for Texas, April 21, 1836. In September a constitution was adopted, General Sam Houston was chosen Governor, and Austin made the state capital. Then followed overtures for annexation to the United States, but this was not accomplished till 1845. The question of the western boundary brought on the Mexican War, which closed in 1848 with the Rio Grande recognized as the boundary. Texas seceded February 1, 1861. It was readmitted to the Union, March 30, 1870. September 8, 1900, Galveston was visited by a hurricane which destroyed 6,000 lives and $18,000,000 in property. Capital, Austin; population, 1910, 29,860.

**Agricultural organization.** Agricultural and Mechanical College and Experiment Station, *College Station*. Sub-stations, *Beeville*, *Denton*, *Lubbock*, *Chillicothe*, *Troupe*, *Beaumont*, *Nagadoches*, *Pecos*, *Temple*, *Angleton*, *Spur*, *Sonora* and *College Station*. Normal and Industrial College, *Prairie View*. Coöperative Demonstration Work, *College Station*. Department of Agriculture, *Austin*. The State Fair is held at *Dallas*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

Population.......................4,663,228; *3,896,542*
City.......1,512,689 (32.4%); *938,104 (24.1%)*
Country..3,150,497 (67.6%); *2,958,438 (75.9%)*
Number of farmers....................436,033; *417,770*
White...359,249 (11.9%); *347,852 (83.3%)*
Non-white.78,784 (18.1%); *6,918 (16.7%)*
Land area, acres..........................167,934,720
Acres in farms................114,020,621; *112,435,067*
Acres farm land improved........31,227,503; *27,360,666*
Average acres per farm............ 261 (71.6 impr.); *269 (65.5 impr.)*
Farm land artificially drained, acres..... 756,263 (2.4% impr. farm land)
Farm land needing drainage, acres.... 4,130,614 (3.6% all farm land)
Farms by size, number:
Up to 19 acres.................... 25,878; *29,371*
20 " 49 " ....................110,387; *98,583*
50 " 99 " ....................119,427; *112,237*
100 " 174 " .................... 96,792; *94,547*
175 " 499 " .................... 59,573; *59,049*
Over 500 " .................... 23,976; *23,956*
Value all farm property...$4,447,420,321; *$2,218,645,164*
Per cent increase in ten years..............100.4; *130.5*
Value farm land..........$3,245,208,649; *$1,633,207,135*
" " buildings..... $454,964,670; *$210,001,260*
" " implements... $154,320,996; *$56,790,260*
" " livestock...... $592,926,006; *$318,646,509*
Av. value all property per farm..........$10,200; *$5,311*
" " land and buildings per acre.....$32.45; *$16.39*
Number farms run by owners...... 201,210 (44.8%); *195,863 (46.8%)*
Number farms run by tenants...... 232,309 (53.3%); *219,575 (52.6%)*
Per cent owned farms unmortgaged..........52.4; *65.4*
Per cent farms reporting automobiles 22.9;telephones32.2

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

Value all farm crops.......$1,071,542,103; *$287,455,020*
" " cereals........... $332,571,641; *$67,109,923*
Corn, acres............. 4,748,655; *5,130,052*
production (bu.).. 108,377,282; *75,498,695*
10-yr. av. yield per acre..............19.4 bu.
Wheat, acres........... 2,414,903; *326,176*
production (bu.).. 36,427,255; *2,560,891*
10-yr. av. yield per acre..............13.3 bu.
Oats, acres............. 1,862,933; *440,001*
production (bu.).. 63,989,423; *7,034,617*
10-yr. av. yield per acre..............29.3 bu.
Rye, acres.............. 14,397; *536*
production (bu.).. 215,385; *4,350*
10-yr. av. yield per acre..............13.2 bu.
Cotton, acres........... 11,522,537; *9,930,179*
production (bales)......2,971,757; *2,455,174*
10-yr. av. yield per acre..............158 lbs.
Hay and forage, acres...... 2,390,457; *1,311,967*
production (tons).. 3,729,651; *1,257,845*
value. ........... $73,324,319; *$13,571,808*
Barley, acres............. 77,780; *3,888*
production (bu.).. 2,188,250; *52,438*
10-yr. av. yield per acre..............23.6 bu.
Buckwheat, acres.......... 128; *57*
production (bu.).. 1,226; *473*
Potatoes, white, acres...... 27,263; *36,092*
production (bu.).. 1,707,251; *2,235,983*
10-yr. av. yield per acre................59 bu.
Sweet, acres........... 68,142; *42,010*
production (bu.).. 5,838,879; *2,730,083*
Potatoes (*continued*)
10-yr. av. yield per acre................86 bu.
Peanuts, acres............ 165,407; *64,327*
production (bu.).. 2,731,632; *1,074,998*
Sugar cane, acres.......... 18,407; *34,315*
production (tons).. 124,493; *307,502*
Sorghum, acres............ 35,589; *10,175*
production (tons).. 45,920; *61,391*
Rice, acres.............. 164,481; *237,586*
production (bu.).. 5,306,369; *8,991,745*
10-yr. av. yield per acre..............33.9 bu.
Small fruits, acres......... 6,139; *5,053*
production (quarts) 6,886,626; *6,182,742*
Strawberries, acres........ 503; *2,161*
production (quarts) 591,476; *4,207,056*
Vegetables, acres 49,093; value $39,187,581; *$12,122,255*
Apples, production (bu.)... 486,828; *168,008*
Pears, production (bu.).... 637,400; *110,967*
Peaches, production (bu.).. 2,924,842; *357,644*
Plums and prunes (bu.).... 294,935; *75,222*
Grapes, production (lbs.)... 2,256,328; *1,802,618*
Forest products, value..... $11,601,597; *$8,925,662*
Nurseries: acres 3,032 in 181 establishments;
receipts...........................$871,192
Greenhouses: sq. ft. under glass 1,253,067;
receipts...........................$795,098

### 3. Livestock, 1920 and *1910*

Number farms reporting livestock............ 409,201; pure breds 26,905
Value all livestock on farms..$592,926,006; *$318,646,509*
Horses, number........... 991,362; *$1,170,068*
value............. $82,271,637; *$84,024,635*
Mules, number........... 845,932; *675,558*
value.............$113,734,227; *$73,979,145*
All cattle, number........ 6,156,715; *6,934,586*
value.............$305,610,919; *$132,985,879*
Beef cattle, number..... 4,693,008;
Dairy cattle, number.... 1,463,707; *1,013,867*
Sheep, number........... 2,573,485; *1,808,709*
value............. $31,651,781; *$6,301,364*
Goats, number........... 357,572; *1,135,244*
value............. $9,967,369; *$2,514,077*
Swine, number........... 2,225,558; *2,336,363*
value............. $30,943,625; *$11,639,366*
Poultry, number.......... 19,024,124; *13,669,645*
value............. $16,674,947; *$4,806,642*
Bees, number of hives..... 232,195; *238,107*
Livestock products, value.... $87,761,715; *$38,097,994*
Value all dairy products... $32,999,946; *$15,679,924*
" eggs and chickens... $43,303,622; *$19,424,711*
" wool and mohair.... $10,421,524; *$2,670,561*
" honey and wax...... $1,036,623; *$322,798*
Milk produced (gallons)... 202,953,536; *197,039,954*
Butter made (lbs.)........ 49,405,152; *64,993,214*
Eggs produced (dozens).... 70,264,074; *77,377,977*

### 4. Irrigation, 1920 and *1910*

Acres in irrigated projects..........1,687,447; *1,253,173*
" of projects irrigable..........1,150,542; *690,991*
" " " irrigated........... 586,120; *451,130*
" " irrigated land open to settlement.......346,446
Capital invested in projects....$35,072,739; *$13,487,347*
Average investment, per acre............$30.48; *$19.52*
Estimated final cost...........$39,860,871; *$14,754,172*
Average cost per acre...................$23.62; *$11.77*
" " maintenance and operation, per acre.........................$6.92; *$3.25*
Acres of crops on irrigated land................295,353
Value of crops on irrigated land............$22,343,976
Av. value crops on irrigated land, per acre (1919) $75.65

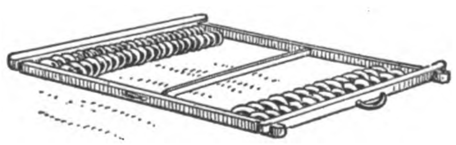
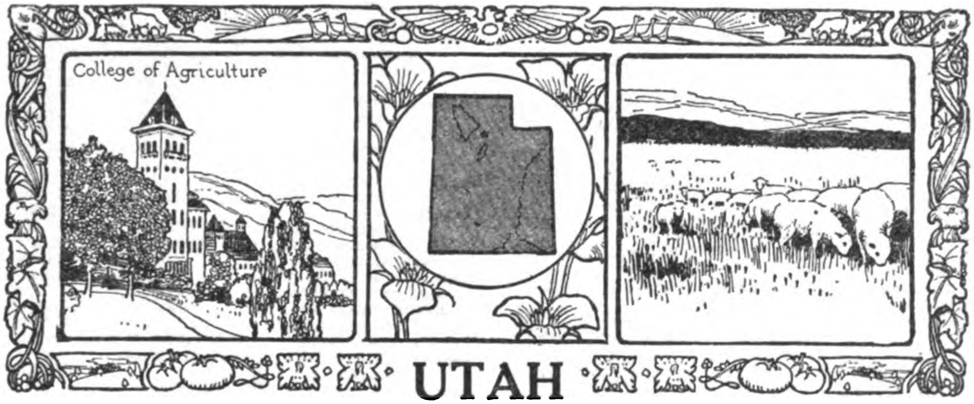


FIG. 376. A Meeker smoothing harrow




**UTAH** ("Salt Lake State"), a Western State, lies between 37 and 42 degrees north latitude, and 109 and 115 degrees west longitude. It is bounded north by Idaho and Wyoming, east by Wyoming and Colorado, south by Arizona, west by Nevada. Its boundaries are all straight lines; it has no natural boundaries. Its extreme dimensions are 345 miles and 275 miles. Area, 84,970 square miles, 2,806 of which are water.

**Land surface.** The Wasatch Mountains traverse the center of the state from north to south. The Uintah Mountains extend to the east from these in the north. In the latter are the highest points in the state, Gilbert, 13,422 feet; Kingspeak, 13,498, highest peak in state; Hodges, Wilson, 13,815; Lovenia and Tokewanna, 13,200 feet. The Wasatch Mountains are 8,000 to 11,500 feet above sea level. East and west of the mountains are elevated plateaus of 4,000 to 6,000 feet. Short mountain ranges of lower elevations jut out from the main chain both east and west. West of the mountains is the Great Basin which extends beyond the state, the great American Desert in the northern part. Between this desert and the mountains is Great Salt Lake, about 75 miles long and 20 to 50 miles wide, with an area of 2,000 square miles, the largest salt lake in America. Most of eastern Utah is drained by the Colorado River and its tributaries. There are several smaller salt lakes.

Soils. The agricultural soils are largely deep, rich, alluvial, loamy or clayey, though near the mountain cañons, gravelly or sandy lands are found. Practically all the farming of the state is done in the various mountain valleys in the center of the state. Most of the soils are very fertile, and yield abundantly when supplied with irrigation water, but some sections are useless for agricultural purposes, unless reeclaimed, because of excessive accumulations of alkali. About 70 per cent of the cultivated area, or nearly 90 per cent of the farms, is irrigated.

**Climate.** Changes in temperature are extreme; in some sections, hot days are followed by cool nights, with low temperatures in winter. Yet the dryness of the air is conducive to health. Temperatures vary greatly at different elevations; the highest recorded is 116 degrees, the lowest 38 degrees below zero. The average annual temperature of the eastern section is 49.8 degrees; of the western and southern 49.3 degrees; of the middle, 47.2 degrees. The frost-free season varies widely. At Salt Lake City, it averages about 170 days, while at some stations, it is nearly 2 months shorter. The average annual rainfall varies from 5.43 inches at one station to 24.36 at another. Most of the precipitation falls as snow during the winter and in spring. The snowfall is light except on the mountains.

**Opportunities.** New land is being brought under cultivation by both dry and irrigation farming methods. On June 30, 1917, 13,846,826 acres were surveyed and awaited homestead settlers. During 1916 and 1917, about 298,877 acres were entered by homesteading. About 17,500,000 acres susceptible to agricultural development were unappropriated in 1914. Unappropriated surveyed public lands, July 1, 1914, 12,411,611 acres. The land offices are at Salt Lake City. The State Industrial Commission collects and distributes information concerning the state. In 1917, about 320,000 acres were under private irrigation projects, and others are being opened continually. The first irrigation by white people in America was begun near Salt Lake City in 1847. Dry-farming also originated in Utah.

**Products and industries.** There is a large variety of agricultural products. The leading grain crops are wheat and oats. Hay is an important crop, largely alfalfa. Large quantities of sugar beets are grown, mostly in the north and central parts. Utah ranks third of the states in the production of beet sugar. Potatoes are the most important vege-

table. Tomatoes and other crops for the canning factories are raised largely in the north. Fruits are grown extensively in several valleys, apples, pears and peaches leading, with the earlier varieties of grapes. Figs are grown in the southwest. Cattle and sheep are the leading livestock, though horses exceed these in value. Lumbering is unimportant, the only merchantable timber being in the Uintah Mountains. There are 14 U. S. Forest Reserves. Leading minerals are gold, silver, copper, lead and coal. Main manufactures are copper smelting and refining, flour and grist-mill products, railway repairs, confectionery, cheese, butter and condensed milk, canned and preserved fruits, beet sugar, meat products, salt.

**Transportation and markets.** Much of the state is deficient in transportation facilities. Electric railways cover the northern half of the state. There is very little water communication. Much of the produce is sold on the local markets, the mines drawing heavily on the farms for supplies.

**History.** The earliest explorers were the Spaniards who came by way of the Colorado River in the south about 1540. Great Salt Lake was discovered by Captain James Bridger in 1824. The first expeditions of which records were left were of Captain Bonneville, 1832–6, and John C. Fremont, 1842–3. The first settlement was made at Salt Lake City in July, 1847, by a band of about 150 Mormons under Brigham Young. The population increased rapidly, reaching 11,380 by 1850. The territory passed into the control of the United States in 1848. Efforts to secure statehood began in 1849; the territory of Utah was organized in 1850, but Utah was not admitted as a state until 1896. Capital, Salt Lake City; population, 1910, 92,777.

**Agricultural organization.** Agricultural College and Experiment Station and Coöperative Demonstration Work, *Logan*. There are the State Board of Land Commissioners, State Live Stock Commission, State Crop Pest Commission, State Board of Horse Commissioners, State and County Farm Bureaus, State Horticultural Society, State Dairymen's Association, State Irrigation Congress, State Dry Farmers' Association, State Beekeepers' Association. The State Fair is held at *Salt Lake City*. The Experiment Station Director reports that agriculture is increasing rapidly in the state. New dry-farming areas are being brought into cultivation. Irrigation areas are being extended by better methods, by the storage of water, and by pumping water for irrigation. The sugar-beet area is being greatly increased. Dairying is finding a larger place. Rotations, better cultural methods, better farm organization, the better use of irrigation water and other improvements are making the agriculture of the state better every year.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 449,396; *373,351* |
| City | 215,584 (48%); *172,934* (*46.3%*) |
| Country | 233,812 (52%); *200,477* (*53.7%*) |
| Number of farmers | 25,662; *21,676* |
| White | 25,246 (98.4%); *21,400* (*98.7%*) |
| Non-white | 414 (1.6%); *276* (*1.3%*) |
| Land area, acres | 52,597,760 |
| Acres in farms | 5,050,410; *3,397,699* |
| Acres farm land improved | 1,715,380; *1,368,211* |
| Average acres per farm | 196.8 (66 impr.); *156.7* (*63* impr.) |
| Farm land artificially drained, acres | 74,316 (4.3% impr. farm land) |
| Farm land needing drainage, acres | 165,926 (3.3% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 4,610; *4,674* |
| 20 " 49 " | 6,549; *5,550* |
| 50 " 99 " | 5,080; *4,170* |
| 100 " 174 " | 4,086; *3,660* |
| 175 " 499 " | 3,867; *2,681* |
| Over 500 " | 1,470; *941* |
| Value all farm property | $311,274,728; *$150,795,201* |
| Per cent increase in ten years | 106.4; *100.6* |
| Value farm land | $210,997,840; *$99,482,164* |
| " " buildings | $32,753,918; *$18,063,168* |
| " " implements | $13,514,787; *$4,468,178* |
| " " livestock | $54,008,183; *$28,781,691* |
| Av. value all property per farm | $12,130; *$6,957* |
| " " land and buildings per acre | $48.26; *$34.60* |
| Number farms run by owners | 22,579 (87.9%); *19,762* (*91.1%*) |
| Number farms run by tenants | 2,787 (10.9%); *1,720* (*7.9%*) |
| Per cent owned farms unmortgaged | 47.6; *76.6* |
| Per cent farms reporting automobiles | 32.1 |
| " " " telephones | 24.5 |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

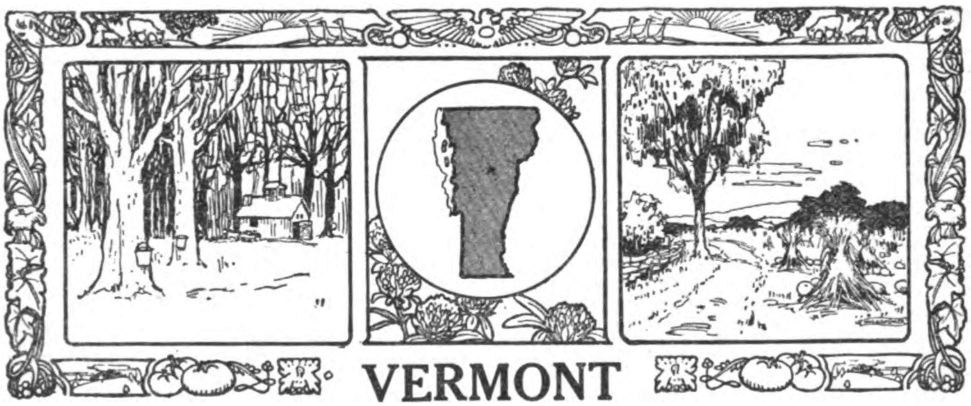
| | | |
|---|---|---|
| Value all farm crops | $58,067,067; | *$18,204,379* |
| " " cereals | $12,388,557; | *$6,092,281* |
| Corn, acres | 13,848; | *7,267* |
| production (bu.) | 265,361; | *169,688* |
| 10-yr. av. yield per acre | | 29.4 bu. |
| Wheat, acres | 268,457; | *178,423* |
| production (bu.) | 4,100,979; | *3,943,910* |
| 10-yr. av. yield per acre | | 21.5 bu. |
| Oats, acres | 61,825; | *80,816* |
| production (bu.) | 1,724,392; | *3,221,289* |
| 10-yr. av. yield per acre | | 44.1 bu. |
| Rye, acres | 10,378; | *5,234* |
| production (bu.) | 72,507; | *65,754* |
| 10-yr. av. yield per acre | | 12.9 bu. |
| Barley, acres | 15,938; | *16,752* |
| production (bu.) | 365,186; | *891,471* |
| 10-yr. av. yield per acre | | 39.2 bu. |
| Hay and forage, acres | 549,967; | *405,394* |
| production (tons) | 1,031,609; | *1,015,913* |
| value | $24,759,397; | *$7,431,492* |
| Potatoes, white, acres | 12,047; | *14,210* |
| production (bu.) | 1,648,400; | *2,409,093* |
| 10-yr. av. yield per acre | | 165 bu. |
| Peanuts, acres | | |
| production (bu.) | | |
| Sugar beets, acres | 93,359; | *27,442* |
| production (tons) | 930,427; | *413,811* |
| Small fruits, acres | 910; | *1,416* |
| production (quarts) | 1,198,200; | *3,118,395* |
| Strawberries, acres | 254; | *719* |
| production (quarts) | 484,792; | *1,832,796* |
| Vegetables, acres 8,309; value | $5,615,888; | *$1,591,847* |
| Apples, production (bu.) | 759,696; | *350,023* |
| Pears, production (bu.) | 76,008; | *38,654* |
| Peaches, production (bu.) | 883,950; | *143,237* |
| Plums and prunes (bu.) | 50,677; | *68,249* |
| Grapes, production (lbs.) | 1,102,625; | *1,576,363* |
| Forest products, value | $120,262; | *$6,730* |
| Nurseries: acres 55 in 15 establishments; receipts | | $20,298 |
| Greenhouses: sq. ft. under glass 487,513; receipts | | $220,864 |

**3. Livestock, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Number farms reporting livestock | 24,463; | pure breds 4,379 |
| Value all livestock on farms | $54,008,183; | *$28,781,691* |
| Horses, number | 125,471; | *115,676* |
| value | $9,642,418; | *$9,999,835* |
| Mules, number | 2,793; | *2,277* |
| value | $190,211; | *$157,497* |
| All cattle, number | 505,578; | *412,334* |
| value | $22,627,870; | *$8,948,702* |
| Beef cattle, number | 397,563; | |
| Dairy cattle, number | 108,015; | *75,810* |
| Sheep, number | 1,691,795; | *1,827,180* |
| value | $18,881,529; | |
| Goats, number | 29,512; | *29,014* |
| value | $253,100; | *$75,447* |
| Swine, number | 99,361; | *64,286* |
| value | $1,351,880; | |
| Poultry, number | 980,097; | *691,941* |
| value | $814,566; | *$327,908* |
| Bees, number of hives | 25,061; | *26,185* |
| Livestock products, value | $13,735,823; | *$5,664,682* |
| Value all dairy products | $4,809,087; | *$2,067,534* |
| Livestock products (*continued*) | | |
| Value eggs and chickens | $2,887,570; | *$1,412,318* |
| " wool and mohair | $5,787,419; | *$2,105,067* |
| " honey and wax | $251,747; | *$79,763* |
| Milk produced (gallons) | 29,339,512; | *20,486,317* |
| Butter made (lbs.) | 2,876,675; | *2,497,366* |
| Eggs produced (dozens) | 5,709,076; | *4,644,829* |

**4. Irrigation, 1920 and *1910***

| | 1920 | *1910* |
|---|---|---|
| Acres in irrigated projects | 2,359,244; | *1,947,625* |
| " of projects irrigable | 1,700,550; | *1,250,246* |
| " " " irrigated | 1,372,651; | *999,410* |
| " " irrigated land open to settlement | 189,563 | |
| Capital invested in projects | $32,037,351; | *$14,028,717* |
| Average investment, per acre | $18.84; | *$11.22* |
| Estimated final cost | $33,835,641; | *$17,840,775* |
| Average cost per acre | $14.34; | *$9.16* |
| " " maintenance and operation, per acre | $1.08; | *$0.65* |
| Acres of crops on irrigated land | 843,219 | |
| Value of crops on irrigated land | $50,114,342 | |
| Av. value crops on irrigated land, per acre (1919) | $59.43 | |




**VERMONT** ("Green Mountain State"), a New England State lies between 42 and 45 degrees north latitude, and 71 and 74 degrees west longitude. The eastern boundary is formed by the Connecticut River, and the larger part of the western by Lake Champlain and the Poultney River. Lake Memphremagog lies on the northern border. Area, 9,564 square miles, 440 of which are water.

Land surface. The average elevation is about 1,000 feet above sea level. The surface is largely mountains, high hills and deep, narrow valleys. The Green Mountains extend the length of the State from North to South, separating the Connecticut from the Hudson River and Lake Champlain. The highest elevation is Mount Mansfield, 4,406 feet. Several small rapid rivers flow into the Connecticut River and Lake Champlain, and two or three each into the Hudson River and Lake Memphremagog.

Soils. These are of glacial origin, those on the hills being better suited to grazing than to tillage. The valley soils are generally of good quality and very fertile. Alluvial soils are found along the streams.

Climate. The winters are somewhat long and cold, the snowfall usually deep, and summers relatively short. Yet the climate is healthful, and most delightful in summer. The highest recorded temperature is 100 degrees, and the lowest 44 degrees below zero. Warm days are followed by cool nights. The average annual frost-free season is about 135 days, but in the higher altitudes, frosts have occurred, in some years, every month. The average annual snowfall varies from 63.6 inches at one station to 110.6 inches at another. The average annual rainfall is 38.7 inches, a large part in the form of snow. Freshets from melting snow are common in spring, sometimes destructive. The winter winds are often severe.

Opportunities. There are practically no abandoned farms, and no untaken public land suitable for agriculture. Particulars about agricultural and other opportunities may be obtained from the Secretary of State, Montpelier.

**Products and industries.** Vermont is not a grain-growing state, and most of the grain grown is fed on the farms. Oats and corn are the leading grains, though hay and forage exceed the value of all the cereals 6 times over. Potatoes exceed in value any of the cereals. Vermont furnishes nearly one-third of the world's supply of maple sugar and sirup, most of it being produced in its northern counties. Cattle are the leading livestock, dairy cows being the larger number. Vermont has always been famed for its horses, and these exceed all other livestock except cattle. Sheep and swine are of considerable importance. Apples are the leading fruit, being grown largely in the Champlain Valley including several islands in the north, in the Hudson River Valley and, to a less extent, in the Connecticut River Valley. A few truck gardens are found in the vicinity of the cities and summer resorts, as are small fruits, but no truck or small fruits are grown on a large commercial scale. Lumbering is an important industry, a considerable proportion of the State still being covered with forests. The leading minerals are marble, granite, slate and talc. Main manufactures are marble and stone products, lumber and timber products, market milk, butter, cheese, sweet cream and condensed milk, woolen, worsted and felt goods, flour and grist-mill products, foundry and machine-shop products. Water power for manufacturing is abundant.

**Transportation and markets.** Vermont is well covered by railroads. Lake Champlain furnishes excellent water communication. Newport and St. Albans are the main ports of entry, and do an extensive business, exports in general far exceeding imports.

History. The Lake Champlain region was first explored by the French under Champlain in 1609, though Cartier may have seen it from Mount Royal at Montreal in 1535. The first settlement was made by the French in 1666 at Fort Saint Anne on Isle La Motte. The first English settlement was made near the present site of Brattleboro in 1724 by Massachusetts colonists. Many other settlements were made during the next half century. In 1759, the French abandoned their settlements which were few and confined to the Champlain Valley. There was much conflict over boundaries because of different grants made by the governors of New York and New Hampshire. Although the boundary dispute was settled in favor of New York, the British Government did not intend to invalidate the titles of lands granted by governor Wentworth of New Hampshire and actually occupied by settlers. New York Governors, however, persisted in regranting these lands, or in making the settlers buy them again at prices considerably larger than those originally paid. The hardy pioneers refused to submit to what they considered a gross injustice, and drove off the New York officials who attempted to evict them. A military organization known as the Green Mountain Boys, and led by Ethan Allen, Seth Warner and others was vigilant in defending the people of New Hampshire Grants, as this region was then known. Trouble continued with New York until after the close of the Revolution. A convention held at Westminster January 15, 1777, declared the Grants to be the independent state of New Connecticut. A later convention changed the name to Vermont, adopted the substance of the Pennsylvania constitution, and declared slavery illegal. On February 18, 1791, Vermont became the first state admitted under the Federal Constitution. Capital, Montpelier; population, 1910, 7,856.

**Agricultural organization.** College of Agriculture and Experiment Station, and Coöperative Demonstration Work, *Burlington*. Commissioner of Agriculture and ex-officio State Forester, State Nursery Inspector, Live Stock Commissioner, State Ornithologist and State Forester, all *St. Albans*. There are, also, a State Grange, Beekeepers', Dairymen's, Forestry, Maple Sugar Makers' and Poultry Breeders' Associations and Horticultural Society. The State Fair is held at *White River Junction*.

The Dean of the State College reports that, "As heretofore, our main products are dairy and lumber products. Our state, within the last ten years, has rapidly changed from a butter to a market-milk state; while a large amount of butter is still made, increasingly the milk leaves the state as such. There has been no development in new systems or rotations, or the exploitation of new lands."

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

**Population**..........................352,428; *355,956*
City.....109,976 (31.2%); *98,917* (*27.8%*)
Country 242,452 (68.8%); *257,039* (*72.2%*)
**Number of farmers**....................29,075; *32,709*
White 29,047 (99.9%); *32,689* (*99.9%*)
Non-white........28 (.1%); *20* (*.1%*)
**Land area, acres**..........................5,839,360
**Acres in farms**..................4,235,811; *4,663,577*
**Acres farm land improved**..........1,691,595; *1,633,965*
**Average acres per farm** 145 (58 impr.); *142.6* (*50* impr.)
**Farm land artificially drained, acres**...... 35,649 (2.1% impr. farm land)
**Farm land needing drainage, acres**..... 68,912 (1.6% all farm land)
**Farms by size, number:**
Up to 19 acres.......................3,350; *4,578*
20 " 49 " .......................2,924; *3,481*
50 " 99 " .......................5,199; *5,910*
100 " 174 " .......................8,777; *9,492*
175 " 499 " .......................8,196; *8,516*
Over 500 " ....................... 629; *732*
Value all farm property......$222,736,620; *$145,399,728*
Per cent increase in ten years.................53.1; *34.1*
Value farm land..............$82,938,253; *$58,385,327*
" " buildings..........$76,178,906; *$54,202,948*
" " implements.........$21,234,130; *$10,168,687*
" " livestock..........$42,385,331; *$22,642,766*
Av. value all property per farm..........$7,661; *$4,445*
" " land and buildings per acre.....$37.56; *$24.14*
**Farms run by owners**....25,121 (86.4%); *28,065* (*85.8%*)
**Farms run by tenants**......3,386 (11.6%); *4,008* (*12.3%*)

Per cent owned farms unmortgaged..........48.3; *52.9*
Per cent farms reporting automobiles 26.2; telephones 57.6

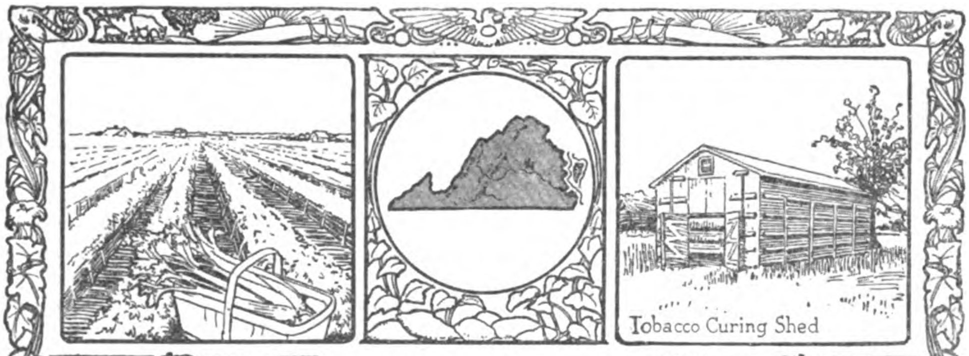
**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value all farm crops | $47,999,600; | *$23,697,700* |
| " " cereals | $5,171,758; | *$2,651,877* |
| Corn, acreage | 21,186; | *42,887* |
| production (bu.) | 937,375; | *1,715,133* |
| 10-yr. av. yield per acre | 43.1 bu. | |
| Wheat, acres | 11,276; | *678* |
| production (bu.) | 176,003; | *14,087* |
| 10-yr. av. yield per acre | 23.8 bu. | |
| Oats, acres | 83,097; | *71,510* |
| production (bu.) | 2,396,349; | *2,141,357* |
| 10-yr. av. yield per acre | 37.6 bu. | |
| Rye, acres | 527; | *1,115* |
| production (bu.) | 6,942; | *16,689* |
| 10-yr. av. yield per acre | 19.6 bu. | |
| Barley, acres | 8,594; | *10,586* |
| production (bu.) | 196,815; | *285,008* |
| 10-yr. av. yield per acre | 30.8 bu. | |
| Hay and forage, acres | 991,757; | *1,030,618* |
| production (tons) | 1,748,358; | *1,502,730* |
| value | $29,581,464; | *$16,335,892* |
| Buckwheat, acres | 4,330; | *7,659* |
| production (bu.) | 6,942; | *16,689* |
| 10-yr. av. yield per acre | 23.8 bu. | |
| Potatoes, white, acres | 24,182; | *26,859* |
| production (bu.) | 2,277,387; | *4,145,630* |
| 10-yr. av. yield per acre | 122 bu. | |
| Maple sugar, trees tapped | 5,955,513; | *5,585,632* |
| sugar made (lbs.) | 6,251,734; | *7,726,817* |
| syrup made (gals.) | 631,924; | *409,953* |
| Small fruits, acres | 694; | *469* |
| production (quarts) | 749,032; | *826,122* |
| Strawberries, acres | 275; | *276* |
| production (quarts) | 428,335; | *615,820* |
| Vegetables, acres 1,905; value | $7,387,254; | *$2,615,299* |
| Apples, production (bu.) | 960,252; | *1,459,689* |
| Pears, production (bu.) | 10,360; | *20,763* |
| Peaches, production (bu.) | 904; | *2,221* |
| Plums and prunes (bu.) | 2,062; | *7,205* |
| Grapes, production (lbs.) | 99,422; | *203,011* |
| Forest products, value | $6,377,580; | *$3,638,537* |

Nurseries: 51 acres in 8 establishments; receipts $25,725
Greenhouses: sq. ft. of glass 272,876; receipts..$196,897

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Farms reporting livestock | 27,269; | pure breds 5,747 |
| Value all livestock on farms | $42,385,331; | *$22,642,766* |
| Horses, number | 77,231; | *80,781* |
| value | $10,421,141; | *$8,591,357* |
| Mules, number | 601; | *429* |
| value | $91,916; | *$53,540* |
| All cattle, number | 435,480; | *430,314* |
| value | $28,502,803; | *$11,828,892* |
| Beef cattle, number | 14,200; | |
| Dairy cattle, number | 421,280; | *265,482* |
| Sheep, number | 62,756; | *118,551* |
| value | $723,683; | *$538,991* |
| Goats, number | 124; | *261* |
| value | $2,414; | *$1,033* |
| Swine, number | 72,761; | *94,821* |
| value | $1,407,410; | *$974,479* |
| Poultry, number | 815,085; | *938,524* |
| value | $1,167,717; | *$607,787* |
| Bees, number of hives | 10,024; | *10,215* |
| Livestock products, value | $31,573,340; | *$14,821,352* |
| Value all dairy products | $27,207,813; | *$12,128,565* |
| " eggs and chickens | $4,038,495; | *$2,474,583* |
| " wool and mohair | $250,977; | *$192,166* |
| " honey and wax | $76,055; | *$26,138* |
| Milk produced (gals.) | 122,095,734; | *114,317,169* |
| Butter made (lbs.) | 3,877,039; | *15,165,692* |
| Eggs produced (dozens) | 5,166,689; | *7,001,897* |




# VIRGINIA

**VIRGINIA** ("Old Dominion State"), a South Atlantic State, lies between 36 and 40 degrees north latitude, and 75 and 84 degrees west longitude. The Potomac River and Chesapeake Bay form the Maryland boundary line on the northeast. Area, 42,627 square miles, 2,635 of which are water.

**Land surface.** This forms three distinct regions: the Coastal Plain, the Piedmont Plain and the Appalachian Plateau. The first slopes gradually from sea level to about 500 feet at the beginning of the Piedmont Plain which rises more abruptly and brokenly to about 1,000 feet at the beginning of the Appalachian Plateau. The last includes the Blue Ridge Mountains, elevation about 2,500 feet, and the Allegheny Mountains on the western boundary, with elevations up to 5,719 feet in Rogers Mountain. Between these ranges is the Great or Shenandoah Valley drained by the Shenandoah River flowing into the Potomac. The Rappahannock, York and James are the other principal rivers flowing into Chesapeake Bay. In the southeast is the Great Dismal Swamp, containing Lake Drummond.

**Soils.** There is great variety in the different sections. Those in the Coastal Plain

are generally light, sandy and gravelly, with some clay. The soils of the Piedmont Region are heavier, well suited to grain, fruit and livestock. In the Shenandoah and tributary valleys are the most fertile soils of the state, largely limestone clays suited to general farming. Alluvial soils are found along the rivers. The mountain and valley soils are suitable for the growth of bluegrass.

Climate. The climate generally is equable and healthful except in some of the low-lying coast regions. The mountain regions are pleasant and healthful throughout the year. Along the coast the weather is hot and sultry in summer. The average annual temperature of the state is about 59 degrees. The average winter temperature is about 40 degrees. The highest recorded temperature is 108 degrees, the lowest, 21 degrees below zero. The average annual rainfall is 52 inches at Norfolk; 24.8 inches at Lynchburg; 38 inches at Staunton. The snowfall is light except in the mountains and nowhere excessive. Average frost-free season about 200 days. Severe or destructive storms are rare.

Opportunities. There is no untaken public land suitable for farming, and there are no abandoned farms. But there is a great deal of land cultivated before the Civil War but now idle a long time, which can be bought at a low price, and responds well to good treatment. A large area in Dismal Swamp could be made into excellent farming land by drainage. Information can be obtained of the Agricultural Experiment Station, Blacksburg, or the State Department of Agriculture and Immigration, Richmond.

Products and industries. Agricultural products are varied because of the variety of soils, elevations and local conditions. The leading grains are corn, wheat and oats. Great quantities of peanuts are grown. Potatoes, sweet potatoes and tobacco are largely grown, and lesser amounts of cotton and sorghum cane. Hay and forage are largely produced. Immense quantities of vegetables are grown, for the northern markets. The leading fruit is apples, some of the finest being grown in the mountain regions; next come peaches, pears, plums and grapes. Strawberries are the most important small fruit. In value of livestock, horses lead, followed by cattle, swine and sheep, though poultry exceed the latter in value. Dairying is important and increasing except in the coast regions. Lumbering has reduced the supply of both pine and hard woods, so is not so important as formerly. In fisheries, Virginia is near the top of the states in value of products, oysters furnishing the largest item in value. The leading minerals are coal and iron. Manufactures have increased largely in recent years. Main ones in order of their value are lumber and timber products, tobacco, flour and gristmill products, railroad shop construction, leather, fertilizers, peanut products, cotton goods, boots and shoes, foundry and machine-shop products, iron and steel.

**Transportation and markets.** Facilities for transportation are excellent both by rail and water. Improved highways are being constructed in nearly all counties. The numerous bays and broad river mouths are great aids in water communication. The coastwise trade is extensive, and great quantities of vegetables and fruits are sent to the northern markets by water. Alexandria, Newport News, Norfolk, Petersburg, and Richmond are ports of entry, most of the business being done by Newport News and Norfolk. The exports far exceed in value the imports.

History. The first permanent English settlement in America was in Virginia, at Jamestown in 1607. The first colonists nearly starved to death, being reduced during the winter of 1609–10 from 500 to 60. On July 30, 1619, the first representative assembly in America met at Jamestown. In 1619, the first slaves were brought into the colony. During the war of Independence, Virginia was invaded many times, and the final campaign centered around Yorktown in 1781. The Virginia Assembly passed a resolution favoring a joint convention of delegates from the various states, which resulted in the Annapolis Convention of September, 1786, which issued the call for the convention that framed the Federal Constitution, 1787. A majority of the people opposed secession, but when Lincoln issued his call for troops, a state convention passed the ordinance of secession, April 25, 1861. Later the people of the eastern part voted approval, but those of the western part repudiated the ordinance, and took steps to form the State of West Virginia. Richmond became the capital of the Confederacy. Virginia rejoined the Union in 1870. Capital, Richmond; population, 1910, 127,628.

**Agricultural Organization.** Agricultural and Mechanical College and Experiment Station, *Blacksburg;* Truck Station, *Norfolk;* County Stations, *Appomattox, Williamsburg, Charlotte, Bowling Green, Holland, Chatham, Martinsville, Staunton.* Coöperative Demonstration Work, *Washington, D. C.* State Department of Agriculture and Immigration, *Richmond.* There are a State Farmer's Institute and Horticultural Society. The State Fair is held at *Richmond.*

**Statistics**

**1. Farms and Farm Property, 1920 and *1910***

| | | |
|---|---|---|
| Population | 2,309,187 | *2,061,612* |
| City | 673,984 (29.2%) | *476,529 (23.1%)* |
| Country | 1,635,203 (70.8%) | *1,585,083 (76.9%)* |
| Number of farmers | 185,242 | *184,018* |
| White | 140,456 (74.3%) | *135,904 (73.9%)* |
| Non-white | 47,786 (25.7%) | *48,114 (26.1%)* |
| Land area, acres | 25,767,680 | |
| Acres in farms | 18,561,112 | *19,495,636* |

Acres farm land improved..........9,460,492; *9,870,058*
Av. acres per farm..94.2 (50.8 impr.); *105.9* (*53.6* impr.)
Acres artificially drained, 225,068 (2.4% impr. farm land)
Acres needing drainage...1,172,580 (6.3% all farm land)
Farms by size, number:

| | | |
|---|---|---|
| Up to 19 acres | 36,402; | *39,746* |
| 20 " 49 " | 45,884; | *42,390* |
| 50 " 99 " | 42,714; | *38,342* |
| 100 " 174 " | 34,011; | *32,997* |
| 175 " 499 " | 23,601; | *26,101* |
| Over 500 " | 3,630; | *4,442* |

Value all farm property....$1,196,555,772; *$625,065,383*
Per cent increase in ten years................91.2; *93.2*
Value farm land............$756,354,277; *$394,658,912*
" " buildings........$268,080,748; *$137,399,150*
" " implements......$50,151,466; *$18,115,883*
" " livestock.......$121,969,281; *$74,891,438*
Av. value all property per farm..........$6,425; *$3,397*
" " land and buildings per acre......55.19; *$27.29*
Farms run by owners..136,363 (77.8%); *133,664* (*72.6%*)
Farms run by tenants...47,745 (25.6%); *48,729* (*26.5%*)
Per cent owned farms unmortgaged..........72.2; *83.4*
Per cent farms reporting automobiles 15.3; telephones 18

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

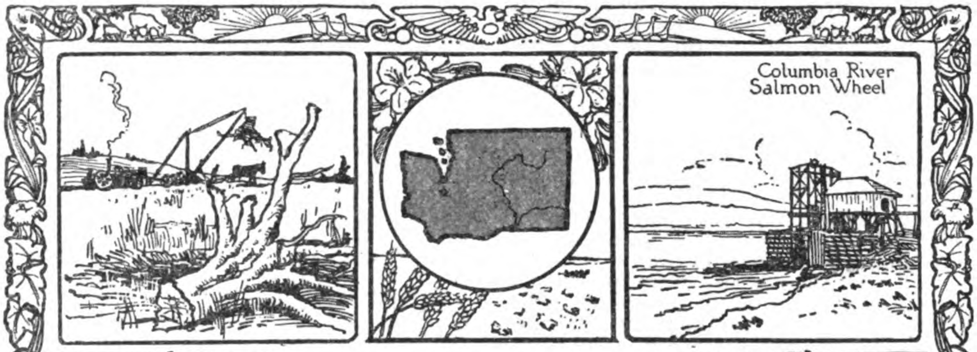
| | | |
|---|---|---|
| Value all farm crops | $292,824,260; | *$89,775,045* |
| " " cereals | $108,723,914; | *$39,993,929* |
| Corn, acres | 1,804,802; | *1,860,359* |
| production (bu.) | 42,302,978; | *38,295,141* |
| 10-yr. av. yield per acre | 26.4 bu. | |
| Wheat, acres | 990,506; | *692,907* |
| production (bu.) | 11,446,027; | *8,076,989* |
| 10-yr. av. yield per acre | 12.8 bu. | |
| Oats, acres | 135,842; | *204,455* |
| production (bu.) | 1,958,609; | *2,884,495* |
| 10-yr. av. yield per acre | 21.9 bu. | |
| Rye, acres | 57,018; | *47,890* |
| production (bu.) | 456,689; | *438,345* |
| 10-yr. av. yield per acre | 12.7 bu. | |
| Cotton, acres | 47,032; | *25,147* |
| production (bales) | 24,887; | *10,480* |
| 10-yr. av. yield per acre | 256 lbs. | |
| Barley, acres | 8,674; | *9,890* |
| production (bu.) | 229,301; | *253,649* |
| 10-yr. av. yield per acre | 26.6 bu. | |
| Buckwheat, acres | 19,354; | *25,481* |
| production (bu.) | 232,507; | *332,222* |
| Hay and forage, acres | 1,773,650; | *773,577* |
| production (tons) | 1,989,282; | *823,383* |
| value | $41,847,594; | *$10,263,458* |
| 10-yr. av. yield per acre | 20.2 bu. | |
| Potatoes, white acres | 105,789; | *86,927* |
| production (bu.) | 12,263,374; | *8,770,778* |
| 10-yr. av. yield per acre | 94 bu. | |
| Potatoes (*continued*) | | |
| Sweet, acres | 42,889; | *40,838* |
| production (bu.) | 5,981,348; | *5,270,202* |
| 10-yr. av. yield per acre | 108 bu. | |
| Peanuts, acres | 133,162; | *145,213* |
| production (bu.) | 5,865,127; | *4,284,340* |
| Tobacco, acres | 225,504; | *185,427* |
| production (lbs.) | 102,391,226; | *132,979,390* |
| 10-yr. av. yield per acre | 702 lbs. | |
| Sorghum, acres | 13,450; | *8,130* |
| production (tons) | 47,011; | *40,875* |
| Small fruits, acres | 3,518; | *7,295* |
| production (quarts) | 4,439,964; | *11,342,980* |
| Strawberries, acres | 2,446; | *6,606* |
| production (quarts) | 3,803,278; | *10,761,381* |
| Vegetables, acres 47,307; value | $55,400,097; | *$17,338,496* |
| Apples, production (bu.) | 8,942,520; | *6,103,941* |
| Pears, production (bu.) | 287,927; | *74,986* |
| Peaches, production (bu.) | 681,528; | *243,446* |
| Plums and prunes (bu.) | 59,561; | *22,597* |
| Grapes, production (lbs.) | 3,970,873; | *4,108,694* |
| Forest products, value | $24,142,423; | *$10,118,851* |

Nurseries: no. 47; acres 425; receipts..........$100,256
Greenhouses: sq. ft. of glass 1,650,354; receipts, $720,779

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 179,200; | pure breds 8,875 |
| Value all livestock on farms | $121,969,281; | *$74,891,438* |
| Horses, number | 312,465; | *330,424* |
| value | $32,791,799; | *$34,857,610* |
| Mules, number | 96,830; | *60,022* |
| value | $13,523,682; | *$7,595,516* |
| All cattle, number | 909,795; | *859,067* |
| value | $51,296,032; | *$21,124,071* |
| Beef cattle, number | 400,490; | |
| Dairy cattle, number | 509,305; | *356,284* |
| Sheep, number | 342,367; | *804,873* |
| value | $3,990,929; | *$3,300,026* |
| Goats, number | 7,469; | *7,327* |
| value | $39,227; | *$28,286* |
| Swine, number | 941,308; | *797,635* |
| value | $10,860,537; | *$4,165,680* |
| Poultry, number | 8,286,676; | *6,099,581* |
| value | $8,909,808; | *$3,396,962* |
| Bees, number of hives | 104,267; | *$104,005* |
| Livestock products, value | $46,311,494; | *$21,473,064* |
| Value all dairy products | $19,167,935; | *$7,704,326* |
| " eggs and chickens | $25,879,870; | *$13,027,512* |
| " wool and mohair | $914,713; | *$567,299* |
| " honey and wax | 348,976; | *173,927* |
| Milk produced (gallons) | 110,942,113; | *95,555,051* |
| Butter made (lbs.) | 25,476,621; | *8,739,620* |
| Eggs produced (dozens) | 36,551,269; | *34,539,082* |

FIG. 377. A papaya orchard in Hawaii




# WASHINGTON

**WASHINGTON** ("Chinook State"), one of the Pacific Coast States, lies between 45 and 49 degrees north latitude, and 116 and 125 degrees west longitude. The Columbia River forms most of the southern boundary, the Snake River a part of the eastern, and the Pacific Ocean the western. Its extreme length from east to west is 340 miles, and width 230 miles. Area, 59,127 square miles, 2,291 of which are water.

**Land surface.** The Cascade Mountains with a general elevation of about 5,000 feet, cross the state from north to south, west of the center, dividing it into two unequal parts. The Cascade Plateau varies from 50 to 100 miles in width. The highest peaks are in the south, Mt. Rainier, 14,363 feet; Mt. Adams, 12,470 feet; Mt. St. Helens, 10,000 feet. In the north, Mt. Baker, 10,827 feet; Glacier Peak, 10,436 feet. East of the mountains is largely a treeless plain with an elevation of 1,200 to 1,800 feet. The Great Plains of the Columbia River, bounded by the Columbia, Spokane and Snake Rivers, are level or undulating, cut by dry cañons. In the southeast corner, the Blue Mountains extend into the State, and in the northeast are mountain spurs. West of the Cascades is the Puget Sound region, the sound extending irregularly halfway across the state. West of this in the northwestern part are the Olympic Mountains, the highest point being Mt. Olympus, 8,150 feet. The narrow coastal plain slopes to the Pacific from the Coast Range. The Columbia is the principal river, entering the state from the northeast, making a great bend to the west, then to the southern boundary and on to the Pacific Ocean. Principal tributaries are the Yakima and Snake, besides many smaller rivers.

**Soils.** In general, the soils of the valleys of western Washington are composed of alluvial and glacial deposits, and are very fertile. Those of eastern Washington are largely of volcanic origin, with some glacial deposits and areas of loam from decayed vegetation, but all needing irrigation for fullest development.

**Climate.** The Cascade Mountains cause a wide difference in climate between the eastern and western portions. West of the mountains, the climate is milder and the rainfall much heavier. So much of the moisture is precipitated as the prevailing westerly winds blow across the mountains, that east of these the air is much drier, and variations in temperature greater. Highest recorded temperature in the west is 105 degrees; lowest, 6 degrees below zero; the average daily range of temperature in the Puget Sound region is from 35 to 45 degrees in midwinter and from 55 to 75 degrees in midsummer. The average frost-free season is about 200 days. The annual rainfall ranges from 60 to 128 inches on the coast, 22 to 60 inches in the Puget Sound Basin and from 60 inches upward on the western slopes of the Cascades. East of the Cascades, the highest recorded temperature is 115 degrees, lowest, 32 degrees below zero; average annual temperatures vary widely, but are lower than in the west. The frost-free season is also shorter. The annual rainfall varies from 6 or 7 inches to 15 or 16 inches, and still higher on the mountains.

**Opportunities.** There are many irrigation projects which provide available lands for settlement. Information about these may be obtained from the U. S. Reclamation Service, Washington, D. C., or from the State Commissioner of Agriculture, Olympia.

**Products and industries.** Leading farm activities are the production of cereals, fruits and livestock. Leading cereals are wheat, largely in the east and southeast, oats and barley. Leading farm animals are horses, cattle, sheep and swine. Dairy cows are an important item. Fruit growing is extensive. Apples are the leading tree fruit, and the late-keeping winter varieties lead all others. Prunes and plums come next, with many

peaches, pears and cherries. The production of potatoes is large, and hops are an important special crop. Lumbering is an important industry, the forest area being large and heavily timbered. Fisheries are very extensive, this state leading all others in some years in value of the products. More than half the product is salmon. The leading mineral is coal. Main manufactures are lumber and fish products.

**Transportation and markets.** Transportation facilities of most of the state are excellent. Puget Sound furnishes an excellent harbor for lines of steamers to all parts of the world. The Columbia River and its tributaries combined are navigable for more than 2,000 miles. Port Townsend is a port of entry, and leads all other Pacific ports in value of export which largely exceed the imports.

**History.** This region was visited in 1592, and the Strait of Juan de Fuca was discovered and named. In 1775, the mouth of the Columbia was discovered; the river was further explored in 1792, and Puget Sound was explored by Captain George Vancouver, after whom Vancouver Island was named. The expeditions of Lewis and Clark, 1805–6, and of Fremont, 1843, furnished the first valuable information on the region. Settlements were made in 1811, 1836, and 1845, but the region was slow to develop till the construction of railroads. Oregon Territory, which included the present State of Washington, was formed in 1848. Washington Territory was formed March 2, 1853, and included parts of Idaho and Montana, its present limit being established in 1863. It became a state in 1889. Capital, Olympia; population, 1910, 6,996.

**Agricultural organization.** College of Agriculture and Experiment Station, *Pullman*. Western Washington Experiment Station, *Puyallup*. Coöperative Demonstration Work, *Pullman*. Commissioner of Agriculture, *Olympia*. Horticultural Association, Dairymen's Association, Beekeepers' Association, Poultry Association, Purebred Stock Breeders' Association, Northwest Live Stock Association, Grain Growers', Shippers' and Millers' Association, Creamery Operators' and Buttermakers' Association, Game Protective and Propagation Association, Game and Fish Protective Association, State Grange, Farmers' Union, State Fair Association.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

Population . . . . . . 1,356,621; *1,141,990*
City . . . . . 748,735 (55.2%); *605,530 (53%)*
Country . 607,886 (44.8%); *536,460 (47%)*
Number of farmers . . . . . . 66,288; *56,192*
White . 65,022 (98.1%); *54,567 (98%)*
Non-white . 1,266 (1.9%); *1,125 (2.%)*
Land area, acres . . . . . . 42,775,040
Acres in farms . . . . . . 13,244,720; *11,712,235*
Acres farm land improved . . . . . . 7,129,343; *6,373,311*
Av. acres per farm. 199.8 (107.5 impr.); *208.4 (113.4 imp.)*
Farm land artificially drained, acres . . . . . 274,696 (3.9% impr. farm land)
Farm land needing drainage, acres . . . . 576,005 (4.3% all farm land)
Farms by size, number:
Up to 19 acres . . . . . . 16,073; *10,529*
20 " 49 " . . . . . . 15,255; *10,252*
50 " 99 " . . . . . . 9,048; *7,105*
100 " 174 " . . . . . . 9,958; *13,884*
175 " 499 " . . . . . . 9,637; *9,215*
Over 500 " . . . . . . 6,317; *5,207*
Value all farm property . . . . $1,057,429,848; *$637,543,411*
Per cent increase in ten years . . . . . . 65.8; *342.6*
Value farm land . . . . . . $797,651,020; *$517,421,998*
" " buildings . . . . . . $122,741,321; *$54,546,459*
" " implements . . . . . . $54,721,377; *$16,709,844*
" " livestock . . . . . . $82,316,130; *$48,865,110*
Av. value all property per farm . . . . . . $15,952; *$11,346*
" " land and buildings per acre . . . . $69.49; *$48.84*
Number farms run by owners . . . . . . 52,701 (79.5%); *47,505 (85.3%)*
Number farms run by tenants . . . . . . 12,419 (18.7%); *7,726 (13.7%)*
Per cent owned farms unmortgaged . . . . . . 47.5; *65.2*
Per cent farms reporting automobiles 41.7; telephones 42.2

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value all farm crops | $227,212,008; | *$74,101,381* |
| " " cereals | $104,886,261; | *$44,762,138* |
| Corn, acres | 34,799; | *26,033* |
| production (bu.) | 901,905; | *563,025* |
| 10-yr. av. yield per acre | | 32.2 bu. |
| Wheat, acres | 2,494,160; | *2,118,015* |
| production (bu.) | 41,837,909; | *40,920,390* |
| 10-yr. av. yield per acre | | 20.4 bu. |
| Oats, acres | 191,673; | *269,742* |
| production (bu.) | 8,073,481; | *13,228,003* |
| 10-yr. av. yield per acre | | 44.8 bu. |
| Rye, acres | 41,677; | *5,450* |
| production (bu.) | 229,653; | *50,746* |
| 10-yr. av. yield per acre | | 16 bu. |
| Barley, acres | 84,568; | *171,888* |
| production (bu.) | 2,249,856; | 5,834,615 |
| 10-yr. av. yield per acre | | 35.2 bu. |
| Hay and forage, acres | 1,064,130; | *742,137* |
| production (tons) | 2,013,913; | *1,391,664* |
| value | $47,717,065; | *$17,200,252* |
| Potatoes, white, acres | 55,132; | *57,897* |
| production (bu.) | 5,866,710; | *7,667,171* |
| 10-yr. av. yield per acre | | 142 bu. |
| Sugar beets, acres | 5,363; | *1,270* |
| production (tons) | 46,386; | *6,556* |
| Buckwheat, acres | 162; | *148* |
| production (bu.) | 2,277; | *3,138* |
| Small fruits, acres | 7,434; | *5,508* |
| production (quarts) | 16,884,745; | *13,590,930* |
| Strawberries, acres | 3,087; | *3,283* |
| production (quarts) | 6,377,368; | *7,683,774* |
| Vegetables, acres 9,460; value | $18,323,982; | *$5,982,665* |
| Apples, production (bu.) | 21,568,691; | *2,672,100* |
| Pears, production (bu.) | 1,728,759; | *310,804* |
| Peaches, production (bu.) | 1,544,859; | *84,494* |
| Plums and prunes (bu.) | 785,920; | *1,032,077* |
| Grapes, production (lbs.) | 3,961,036; | *1,704,005* |
| Forest products, value | $4,738,116; | *$3,754,293* |
| Nurseries: acres 368 in 76 establishments; receipts | | $308,665 |
| Greenhouses: sq. ft. under glass 2,680,369; receipts | | $1,046,021 |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Number farms reporting livestock | 60,821; | pure breds 7,075 |
| Value all livestock on farms | $82,316,130; | *$48,865,110* |
| Horses, number | 296,381; | *280,572* |
| value | $25,069,336; | *$29,680,849* |
| Mules, number | 23,091; | *12,185* |
| value | $2,930,813; | *$1,776,297* |
| All cattle, number | 572,644; | *402,120* |
| value | $36,558,959; | *$12,193,465* |
| Beef cattle, number | 193,819; | |
| Dairy cattle, number | 378,825; | *186,233* |

**Value all livestock on farms** (*continued*)

| | | |
|---|---|---|
| Sheep, number | 623,779; | *475,555* |
| value | $7,750,407; | *$1,931,170* |
| Goats, number | 6,830; | *8,621* |
| value | $78,306; | *$31,662* |
| Swine, number | 264,747; | *206,135* |
| value | $5,049,259; | *$1,674,927* |
| Poultry, number | 3,614,475; | *2,272,775* |
| value | $4,398,759; | *$1,367,440* |
| Bees, number of hives | 56,806; | *33,884* |
| Livestock products, value | $44,066,349; | *$15,538,705* |
| Value all dairy products | $27,620,231; | *$8,746,041* |
| " eggs and chickens | $13,779,958; | *$6,184,899* |
| " wool and mohair | $2,258,739; | *$541,374* |
| " honey and wax | $407,421; | *$66,391* |
| Milk produced (gallons) | 140,524,518; | *70,083,033* |
| Butter made (lbs.) | 5,899,678; | *6,751,575* |

**Livestock products** (*continued*)

| | | |
|---|---|---|
| Eggs produced (dozens) | 21,356,576; | *16,373,740* |

**4. Irrigation, 1920 and *1910***

| | |
|---|---|
| Acres in irrigated projects | 836,795; *817,032* |
| " of projects irrigable | 637,151; *470,514* |
| " " " irrigated | 529,899; *334,378* |
| " " irrigated land open to settlement | 61,738 |
| Capital invested in projects | $29,299,011; *$16,219,149* |
| Average investment, per acre | $45.98; *$34.47* |
| Estimated final cost | $37,684,591; *$22,322,856* |
| Average cost per acre | $45.03; *$27.32* |
| Average cost maintenance and operation, per acre | $3.45; *$3.08* |
| Acres of crops on irrigated land | 395,196 |
| Value of crops on irrigated land | $39,801,619 |
| Av. value crops on irrigated land, per acre (1919) | $100.71 |


# WEST VIRGINIA

**WEST VIRGINIA** ("Panhandle State"), a South Atlantic State, lies between 37 and 41 degrees north latitude, and 77 and 83 degrees west longitude. Area, 24,170 square miles, 148 of which are water.

**Land surface.** Nearly the entire state is mountainous or hilly. It lies in the Allegheny Plateau. Along the southeastern boundary, are mountain ranges from which most of the surface slopes toward the Ohio River. The northeastern part is in the Potomac Valley, and the Monongahela River, which rises in the northern part, flows into Pennsylvania uniting there with the Allegheny to form the Ohio. In the southern part are other irregular mountain ranges of lesser elevation. The highest elevation is Spruce Knob, Pendleton County, 4,860 feet, while along the Ohio it ranges from 500 to 600 feet above sea level. The slopes of the southern mountain ranges are gentle for the most part. The principal rivers within the state are the Little Kanawha, Great Kanawha and Guyandotte.

**Soils.** These are mostly very fertile, even on the mountain slopes. They are largely of limestone origin, especially those of the eastern part which are the most fertile of any in the state. In the higher part of the northeast are some clay soils. In the extreme northeast are some poorer sandy soils. Toward the Ohio River are clay and sand loams, with considerable humus and disintegrated limestone.

**Climate.** The temperature is quite variable, but the climate generally is pleasant and healthful. The highest recorded temperature is 107 degrees, and the lowest, 35 degrees below zero, though these figures are extreme and may not be again approached for many years. The average annual temperature of the mountain regions is about 50 degrees, the rest of the state ranging a few degrees higher. The frost-free season is about 165 days, varying according to location. The snowfall is light and of short duration along the Ohio River, somewhat heavier in the center of the State, and often quite heavy in the mountains. The average annual rainfall is about 44 inches, being higher in the mountain regions. The greatest precipitation is usually in March and June, the driest months being from September to November. Destructive storms are rare.

**Opportunities.** West Virginia offers excellent opportunities for endeavor and investment along many lines. It has vast waterpower little utilized. Bluegrass pastures, excellent transportation facilities and good markets encourage the production of livestock. Thousands of acres of land in the river valleys are suitable for truck and other crops.

The eastern panhandle is particularly adapted to the production of apples and peaches. The Department of Agriculture, Charleston, publishes annually a list of farms for sale throughout the State.

**Products and industries.** Leading farm activities are dairying and truck gardening around cities, the raising of livestock in the mountain regions, with fruit in some parts, especially in the eastern part, and mixed farming in the rest of the state. Leading grain crops are corn, wheat and oats. The leading fruits are apples and peaches. Early apples for the northern markets are grown in the Ohio Valley counties, and winter apples in the east. Melon growing is extensive in the southern Ohio River counties. Aside from this, vegetable growing is mostly for local markets. Potatoes and tobacco are extensively grown. Leading livestock are horses, beef and dairy cattle; sheep and swine are also important. Bluegrass thrives in most of the state, and this favors the livestock industry. Agricultural development has been very rapid during the past few years. Purebred beef and dairy cattle, horses, sheep, swine and poultry are found in practically every county. Improved breeding is practised as community projects. Dairy testing associations are doing good work. Sheep are well suited to the steep pastures. There is a great demand for sheep, and several carloads of breeders were shipped into the State during 1917. The eastern panhandle is unexcelled for good quality fruit. Farmers are practising the most scientific methods of using fertilizers resulting in increased crop yields. Lumbering is an important industry, though much of the original forest area has been cleared. The state is rich in minerals; leading ones are coal, iron, natural gas and oil. Main manufactures are lumber and timber products, steel and iron, leather, glass, flour and grist-mill products, coke, railroad cars, meat products, foundry and machine-shop products.

**Transportation and markets.** The state is fairly well supplied with railroads. The Ohio River furnishes excellent water transportation along the western boundary, and the mountain streams and rivers are used for rafting lumber, and for small vessels. Within the state are 600 miles of brick and concrete roads, 932 miles of macadam and asphalt, and 1,773 miles of improved earth roads, with many more miles being built each year.

**History.** The present state of West Virginia was a part of the original Virginia Colony and State till the Civil War. It was not settled so early as the eastern part on account of the mountain barriers. The earlier settlers came from nearby Pennsylvania, Virginia and Maryland points. The first cabin was erected in 1727 by Morgan Morgan. In 1751–2, part of the region was explored by the first Ohio Company. After the secession of Virginia from the Union, April 17, 1861, representatives from 26 of the western counties met at Wheeling, May 13, repudiated the ordinance of secession, and summoned a "Virginia State Convention," to meet at Wheeling, June 11. The second convention declared the state offices vacant, and organized a provisional government. The legislature of the new government met July 2 and elected United States senators who were seated by Congress. A third convention met November 26, which drafted a constitution which was ratified by popular vote April, 1862, and on June 20, 1863, West Virginia was formally admitted to statehood. The capital was first at Wheeling, then at Charleston, then at Wheeling, then moved back to Charleston, which has been the capital since May 1, 1885. Population of Charleston, 1915, 35,000.

**Agricultural organization.** College of Agriculture and Experiment Station, *Morgantown;* substations, *Wardensville* and *Huntington.* Colored Institute, *Institute.* Coöperative Demonstration Work, *Morgantown.* State Fair is held at *Wheeling.* West Virginia Collegiate Institute, located at *Institute,* maintains a department of Agricultural Extension Work and Home Economics for Colored People.

The Experiment Station Director reports that the College of Agriculture and Experiment Station have done excellent work in improving agricultural conditions. Under their direction are six farms totalling 1,630 acres and devoted respectively to horticulture, agronomy, livestock, dairy and poultry work. All farms are under the general direction of the University professors, are well equipped, and are doing excellent experimental work. The Extension Department is made up of about 25 specialists who give part or all of their time to Agricultural Extension Work. Coöperative Demonstration work in Agriculture and Home Economics is carried on in almost every county. There are county agricultural agents in about two thirds of the counties.

### Statistics

**1. Farms and Farm Property, 1920 and *1910***

| | |
|---|---|
| Population | 1,463,701; *1,221,119* |
| City | 369,007 (25.2%); *228,242 (18.7%)* |
| Country | 1,094,694 (74.8%); *992,877 (81.3%)* |
| Number of farmers | 87,289; *96,685* |
| White | 86,785 (99.4%); *95,977 (99.3%)* |
| Non-white | 504 (.6%); *708 (.7%)* |
| Land area, acres | 15,374,080 |
| Acres in farms | 9,569,790; *10,026,442* |
| Acres farm land improved | 5,520,308; *5,521,757* |
| Av. acres per farm | 109.6 (62.5 impr.); *103.7* (*57* impr.) |
| Acres artificially drained | 38,464 (.7% impr. farm land) |
| Acres needing drainage | 310,868 (3.2% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 10,410; *15,399* |
| 20 " 49 " | 18,155; *20,323* |
| 50 " 99 " | 25,587; *26,806* |
| 100 " 174 " | 19,539; *20,156* |
| 175 " 499 " | 11,990; *12,248* |
| Over 500 " | 1,608; *1,753* |
| Value all farm property | $496,439,617; *$314,738,540* |

| | | |
|---|---|---|
| Per cent increase in ten years | 57.4; | *54.4* |
| Value farm land | $307,309,704; | *$207,075,759* |
| " " buildings | $103,473,702; | *$57,315,195* |
| " " implements | $18,395,058; | *$7,011,513* |
| " " livestock | $67,261,153; | *$43,336,073* |
| Av. value all property per farm | $5,687; | *$3,255* |
| " " land and buildings per acre | $42.93; | *$26.37* |
| Farms run by owners | 72,101 (82.6%); | *75,978 (79.1%)* |
| Farms run by tenants | 14,098 (16.2%); | *19,835 (20.5%)* |
| Per cent owned farms unmortgaged | 73; | *87* |

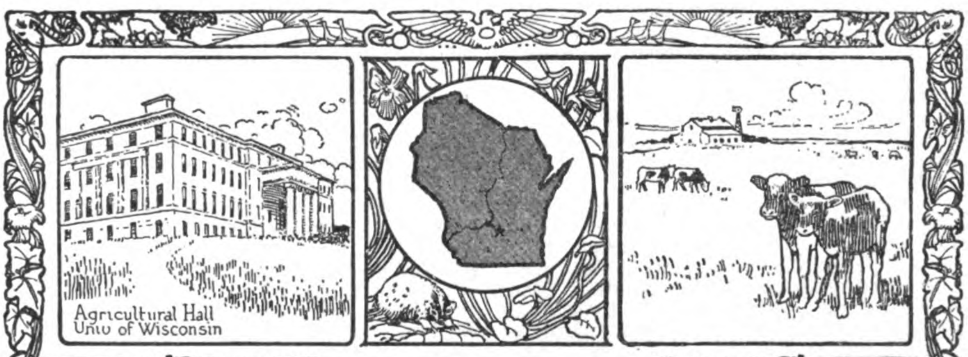
Per cent farms reporting automobiles 15.3; telephones 18

**2. Crop Acreages, Yields, Values, 1919 and *1909***

| | | |
|---|---|---|
| Value all farm crops | $96,537,459; | *$36,167,014* |
| " " cereals | $42,447,028; | *$15,997,700* |
| Corn, acres | 568,219; | *676,311* |
| production (bu.) | 17,010,357; | *17,119,097* |
| 10-yr. av. yield per acre | 31.2 bu. | |
| Wheat, acres | 298,036; | *209,315* |
| production (bu.) | 3,747,812; | *2,575,996* |
| 10-yr. av. yield per acre | 13.8 bu. | |
| Oats, acres | 169,915; | *103,758* |
| production (bu.) | 3,054,668; | *1,728,806* |
| 10-yr. av. yield per acre | 25.2 bu. | |
| Rye, acres | 19,760; | *15,679* |
| production (bu.) | 186,709; | *148,676* |
| 10-yr. av. yield per acre | 13.3 bu. | |
| Barley, acres | 1,359; | *408* |
| production (bu.) | 24,816; | *8,407* |
| Hay and forage, acres | 910,550; | *708,900* |
| production (tons) | 1,099,679; | *639,104* |
| value | $23,746,574; | *$7,493,106* |
| Buckwheat, acres | 31,095; | *33,323* |
| production (bu.) | 537,883; | *533,670* |
| 10-yr. av. yield per acre | 21.1 bu. | |
| Potatoes, white, acres | 34,526; | *42,621* |
| production (bu.) | 2,809,398; | *4,077,066* |
| 10-yr. av. yield per acre | 91 bu. | |
| Sweet, acres | 2,678; | *2,079* |
| production (bu.) | 221,378; | *215,582* |
| 10-yr. av. yield per acre | 114 bu. | |
| Tobacco, acres | 11,233; | *17,928* |
| production (lbs.) | 7,587,052; | *14,356,400* |
| 10-yr. av. yield per acre | 780 lbs. | |
| Maple sugar cane, trees tapped | 73,518; | *97,274* |
| sugar made (lbs.) | 73,763; | *140,060* |
| syrup made (gal.) | 23,448; | *31,176* |
| Sorghum, acres | 8,439; | *8,607* |
| production (tons) | 30,544; | *48,091* |
| Small fruits, acres | 3,162; | *2,913* |
| production (quarts) | 2,092,376; | *2,336,562* |
| Strawberries, acres | 1,006; | *709* |
| production (quarts) | 840,273; | *812,049* |
| Vegetables, acres 8,377; value | $16,715,867; | *$6,968,618* |
| Apples, production (bu.) | 4,189,162; | *4,225,163* |
| Pears, production (bu.) | 33,364; | *29,916* |
| Peaches, production (bu.) | 706,411; | *328,901* |
| Plums and prunes (bu.) | 37,099; | *32,948* |
| Grapes, production (lbs.) | 2,186,740; | *3,224,751* |
| Forest products, value | $11,346,421; | *$4,004,484* |
| Nurseries: acres 188 in 33 establishments; receipts | $38,854 | |
| Greenhouses: sq. ft. under glass 467,721; receipts | $210,812 | |

**3. Livestock, 1920 and *1910***

| | | |
|---|---|---|
| Number farms reporting livestock | 84,310; | pure breds 7,136 |
| Value all livestock on farms | $67,261,153; | *$43,336,073* |
| Horses, number | 169,148; | *179,991* |
| value | $17,829,634; | *$18,583,381* |
| Mules, number | 14,981; | *11,717* |
| value | $1,839,287; | *$1,339,760* |
| All cattle, number | 587,462; | *620,288* |
| value | $33,727,219; | *$15,860,764* |
| Beef cattle, number | 332,441; | |
| Dairy cattle, number | 255,021; | *239,539* |
| Sheep, number | 509,831; | *910,360* |
| value | $5,049,727; | *$3,400,901* |
| Goats, number | 7,003; | *5,748* |
| value | $61,000; | *$20,682* |
| Swine, number | 305,211; | *328,188* |
| value | $4,046,132; | *$2,087,392* |
| Poultry, number | 8,286,676; | *6,099,581* |
| value | $4,230,975; | *$1,628,700* |
| Bees, number of hives | 104,267; | *104,005* |
| Livestock products, value | $26,332,970; | *$11,984,911* |
| Value all dairy products | $11,390,209; | *$5,000,138* |
| " eggs and chickens | $13,042,688; | *$5,910,889* |
| " wool and mohair | $1,593,776; | *$842,254* |
| " honey and wax | $306,297; | *$231,630* |
| Milk produced (gallons) | 73,690,103; | *71,320,033* |
| Butter made (lbs.) | 17,715,107; | *18,969,699* |
| Eggs produced (dozens) | 21,708,279; | *18,948,259* |




# WISCONSIN

**WISCONSIN** ("Badger State"), one of the North Central States, lies between 42 and 48 degrees north latitude, and 86 and 93 degrees west longitude. Lake Superior bounds it on the north, and Lake Michigan on the east. The western boundary is formed largely by the Mississippi, St. Croix and St. Louis Rivers, and part of the northern by the Menominee. The state includes the Apostle Islands in Lake Superior, and a group of islands at the entrance to Green Bay on the Lake Michigan side. Area 56,066 square miles, 810 of which are water.

**Land surface.** Wisconsin is in the northern part of the Great Central Plain. The surface is mostly rolling. The highest elevation is in the north, a range of low-lying hills reaching about 1,700 feet. The larger part of the state

drains into the Mississippi River, the dividing line extending from the northern boundary to the Illinois line, at an elevation of 1,200 to 1,600 feet. In the north, this separates the Wisconsin River Valley from the Mississippi; farther south it separates the same valley from the Lake Michigan drainage region. The principal river, the Wisconsin, rises in the north, flows south through the center to within 80 miles of the southern boundary, then turns west into the Mississippi. Other rivers flowing into the Mississippi are the Chippewa and Black. Green Bay on the east receives the Fox River, the outlet of Lake Winnebago, the largest lake within the state. There are numerous smaller and picturesque lakes and some swamps in the south central areas, in a number of which drainage districts have been formed.

**Soils.** Except in the extreme southwestern portion, the soils of the greater part of Wisconsin owe their origin to repeated glaciation. Because of the different processes by which the soils have been formed and the wide range in characteristics of the original mineral material from which they are directly or indirectly derived, there is diversity in types. A variety of fertile upland soils have thus been given a broad distribution over the state. Clay loams predominate. The soils of northern Wisconsin are nearly all highly productive. The productive soils may be divided into three general classes: clay loams, sandy loams and red clays. The clay loams occupy much the greater portion of northern Wisconsin. In the south central area are irregular tracts of sandy loams and sandy soils. Most of the soils of lower Wisconsin consist of clay loam or sandy loam. There are areas of low, wet lands rather more extensive in parts of four south central counties and one northern county than elsewhere. In average yield per acre of principal farm crops, there is little difference among counties and one is almost safe in saying that all of the soils are found in all the counties.

**Climate.** Variation in the surface of the state of course influences climate. Wisconsin's geographical position, the arrangement of its high land and closeness to the Great Lakes, create a temperate climate. Lakes Michigan and Superior are said to have an average depth of 800 feet, possess a surface area equal to that of the whole state, and exert a marked influence on temperatures. While the climate is continental, and like all continental climates is subject to change, nevertheless, the time for seeding oats is quite uniform throughout the state, ranging from the first to the last of April. Corn is planted from May 10 to June 1. There are distinct climatic provinces in Wisconsin and some variation in the period between killing frosts. The average annual temperature ranges from 40 to 41 degrees in the northern part and from 45 to 47 degrees in the southern. Corn is grown throughout the state, but in the north central and more northern counties, principally for silage. Small grains, potatoes, and garden vegetables mature in all parts of the state. The rainfall varies from 28 to 33 inches but is heavier in some parts than in others. The snowfall is usually abundant, especially in the northern part. Winter temperatures in northern Wisconsin are about 8 degrees lower than in the southeastern corner of the state.

**Opportunities.** Large areas of new land are available for settlement in the central and northern part of the state, from which most of the heavy timber has been removed, and is known as "cut-over" land. It is owned chiefly by lumber companies, railroads and colonization companies. A large part of it is already in farms. About 90,000 acres are being brought under cultivation each year in 26 northern counties. A great deal more is being brushed off and converted into pasture and hay land every year. The unimproved land can be bought at prices ranging from $15 to $30 per acre, and on long-time payments. The amount available is estimated to be from 8 million to 9 million acres. This region is especially noted for its grasses. Information may be obtained from the Division of Immigration, Department of Agriculture, Madison.

**Products and Industries.** Agriculture is the leading industry. The principal products are grain, livestock and dairy products, vegetables and tobacco. The leading grains are oats, corn and barley. Great quantities of potatoes are grown in the central and northwestern part. In the southwestern part, considerable tobacco is grown. Large quantities of peas and corn for canning are grown, as well as sugar-beets and truck crops. Apples and plums are grown throughout the state for home use, and commercially near the Great Lakes and in the western portion. Small fruits also do well, and cranberries are grown in the south central area. Dairying is the most important part of the livestock industry. Horses, cattle, swine and sheep are the leading livestock. Poultry exceed sheep in value. Lumbering is now confined principally to hardwoods. Fisheries are most extensive near the Great Lakes. Leading minerals are iron ore, zinc and lead. Main manufactures are lumber and timber products; foundry and machine shop products; butter, cheese and condensed milk; leather, malt liquors; flour and grist-mill products; meat products; paper and wood pulp; furniture; boots and shoes; automobiles and agricultural implements.

**Transportation and Markets.** Transportation facilities are excellent both by railroad and water. The state is well covered with railroads. Railroads have good terminal facilities at points on the Great Lakes, and a large tonnage of freight is handled by vessel

plying those waters. There are 78,000 miles of public roads, and the average haul from farm to market is 5.6 miles. It would be difficult to find many points in the state more than 14 miles from some railroad.

History. Eastern Wisconsin was explored as early as 1634, and Jesuit missions were established in 1665 and 1668. The first permanent settlement was made on Green Bay in 1750. Early explorers and settlers were largely French, but joined the English in the Revolution and in the War of 1812. The United States took formal possession in 1816. Wisconsin was successively a part of the Northwest Territory, Indiana Territory, Michigan Territory, Illinois Territory and again a part of Michigan Territory. In 1836, Wisconsin Territory was organized, including also Minnesota, Iowa and about half of the Dakotas. On May 29, 1848, it became a state with its present limits. Capital, Madison; population, 1910, 25,531.

Agricultural organization. College of Agriculture and Experiment Station, *Madison*; Cranberry Experiment Station, *Grand Rapids*; the State Department of Agriculture, Live Stock Breeders' Association, State Horticultural Society and Wisconsin Experiment Association, all at *Madison*. The State Fair is held at *Milwaukee*.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

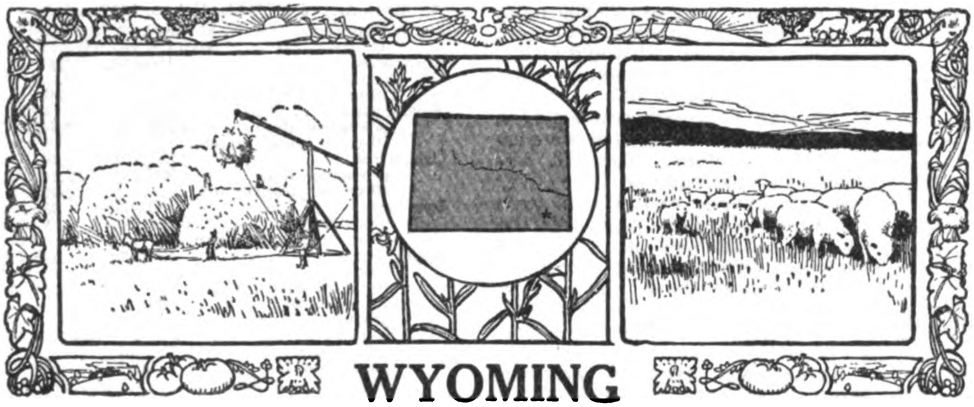
| | | |
|---|---|---|
| Population | 2,632,067; | *2,333,860* |
| City | 1,244,568 (47.3%); | *1,004,320 (43.%)* |
| Country | 1,387,499 (52.7%); | *1,329,540 (57.%)* |
| Number of farmers | 189,295; | *177,127* |
| White | 188,632 (99.6%); | *176,536 (99.7%)* |
| Non-white | 663 (.4%); | *591 (.3%)* |
| Land area, acres | 35,363,840 | |
| Acres in farms | 22,148,223; | *21,060,066* |
| Acres farm land improved | 12,432,216; | *11,907,606* |
| Average acres per farm | 117 (66.3 impr.); | *119 (67 impr.)* |
| Farm land artificially drained, acres | 658,411 (5.3% impr. farm land) | |
| Farm land needing drainage, acres | 1,839,273 (8.3% all farm land) | |
| Farms by size, number: | | |
| Up to 19 acres | 9,854; | *10,647* |
| 20 " 49 " | 24,814; | *23,460* |
| 50 " 99 " | 60,725; | *54,007* |
| 100 " 174 " | 63,653; | *58,439* |
| 175 " 499 " | 29,190; | *29,467* |
| Over 500 " | 1,059; | *1,107* |
| Value all farm property | $2,677,282,977; | *$1,413,118,785* |
| Per cent increase in ten years | 89.2; | *74.1* |
| Value farm land | $1,618,913,059; | *$911,938,261* |
| " " buildings | $568,968,914; | *$289,694,462* |
| " " implements | $167,088,909; | *$52,956,579* |
| " " livestock | $322,312,115; | *$158,529,483* |
| Av. value all property per farm | $14,143; | *$7,978* |
| " " land and buildings per acre | $98.78; | *$57.06* |
| Number farms run by owners | 159,610 (84.2%); | *151,022 (85.2%)* |
| Number farms run by tenants | 27,258 (14.4%); | *24,654 (13.9%)* |
| Per cent owned farms unmortgaged | 36.2; | *48.3* |
| Per cent farms reporting automobiles 49.6; telephones 59.1 | | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $445,347,868; | *$137,830,966* |
| " " cereals | $170,196,910; | *$73,141,919* |
| Corn, acreage | 1,150,783; | *1,457,652* |
| production (bu.) | 44,547,398; | *49,163,034* |
| 10-yr. av. yield per acre | | 36.5 bu. |
| Wheat, acres | 529,745; | *140,369* |
| production (bu.) | 7,328,444; | *2,641,476* |
| 10-yr. av. yield per acre | | 18.9 bu. |
| Oats, acres | 2,251,919; | *2,164,570* |
| production (bu.) | 68,296,223; | *71,349,038* |
| 10-yr. av. yield per acre | | 38.3 bu. |
| Rye, acres | 529,063; | *339,213* |
| production (bu.) | 6,672,383; | *4,797,975* |
| 10-yr. av. yield per acre | | 17.2 bu. |
| Barley, acres | 498,292; | *816,449* |
| production (bu.) | 12,191,861; | *22,156,041* |
| 10-yr. av. yield per acre | | 29.9 bu |
| Hay and forage, acres | 4,495,988; | |
| production (tons) | 11,489,227; | |
| value | $164,993,480; | *$40,872,938* |
| Potatoes, white, acres | 294,424; | *290,185* |
| production (bu.) | 26,376,021; | *31,968,195* |
| 10-yr. av. yield per acre | | 103 bu. |
| Maple sugar, trees tapped | 497,141; | *449,727* |
| sugar made (lbs.) | 22,430; | *27,199* |
| syrup made (gals.) | 138,627; | *124,117* |
| Tobacco, acres | 41,465; | *40,458* |
| production (bu.) | 52,454,246; | *46,909,182* |
| 10-yr. av. yield per acre | | 1,192 lbs. |
| Sugar beets, acres | 12,787; | *12,308* |
| production (tons) | 136,208; | *126,646* |
| Sorghum, acres | 4,906; | *2,244* |
| production (tons) | 18,225; | *13,498* |
| Small fruits, acres | 7,991; | *6,305* |
| production (quarts) | 10,388,225; | *9,782,779* |
| Strawberries, acres | 3,652; | *2,863* |
| production (quarts) | 5,203,127; | *5,188,117* |
| Vegetables, acres 68,283; value | $77,613,026; | *$12,311,816* |
| Apples, production (bu.) | 1,305, 984; | *2,232,112* |
| Pears, production (bu.) | 13,453; | *12,992* |
| Peaches, production (bu.) | 352; | *956* |
| Plums and prunes (bu.) | 21,354; | *15,907* |
| Grapes, production (lbs.) | 648,893; | *701,329* |
| Forest products, value | $16,587,974; | *$9,559,428* |
| Nurseries: 567 acres in 124 establishments; receipts | | $263,649 |
| Greenhouses: sq. ft. under glass 4,128,133; receipts | | $2,094,774 |

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 183,839; | pure breds 38,666 |
| Value all livestock on farms | $322,312,115; | *$158,529,483* |
| Horses, number | 683,364; | *614,654* |
| value | $66,587,715; | *$68,585,509* |
| Mules, number | 4,284; | *2,872* |
| value | $481,208; | *$316,066* |
| All cattle, number | 3,050,829; | *2,680,074* |
| value | $208,673,216; | *$67,475,224* |
| Beef cattle, number | 287,346; | |
| Dairy cattle, number | 2,763,483; | *1,473,505* |
| Sheep, number | 479,991; | *929,783* |
| value | $5,291,347; | *$3,669,652* |
| Goats, number | 2,484; | *4,875* |
| value | $20,519; | *$* |
| Swine, number | 1,596,419; | *1,809,331* |
| value | $29,956,038; | *$13,620,741* |
| Poultry, number | 11,762,273; | *9,433,110* |
| value | $10,726,721; | *$4,468,703* |
| Bees, number of hives | 107,646; | *95,638* |
| Livestock products, value | $213,022,023; | *$69,552,551* |
| Value all dairy products | $180,306,599; | *$53,868,028* |
| " eggs and chickens | $30,288,326; | *$14,180,433* |
| " wool and mohair | $1,693,215; | *$1,268,367* |
| " honey and wax | $7,333,883; | *$235,723* |
| Milk produced (gals.) | 858,258,521; | *458,327,649* |
| Butter made (lbs.) | 8,666,037; | *27,200,509* |
| Eggs produced (dozens) | 53,222,114; | *50,269,446* |



# WYOMING

**WYOMING** ("Equality State"), one of the Western States, lies between 41 and 45 degrees north latitude, and 104 and 112 degrees west longitude. Area, 97,914 square miles, 320 of which are water.

**Land surface.** Wyoming is a mountain state, lying in the Rocky Mountain region. It is one vast plateau with a general elevation of 4,000 to 7,000 feet, with numerous irregular mountain ranges rising to elevations of 9,000 to 11,000 feet. These are included in the Continental Divide which crosses the state from the northwest corner to the middle of the southern boundary. These mountain ranges break up the state into a number of irregular plains. The famed Yellowstone National Park is in the northwest corner. The highest point in the state is Fremont Peak, 13,790 feet, and several others exceed 13,000 feet. The principal rivers are the Platte, draining the southeastern part, the waters reaching the Missouri and Mississippi Rivers and the Gulf of Mexico; the Green in the southwest flowing into the Colorado and the Gulf of California; the Snake in the northwest, which is tributary to the Columbia, reaching the Pacific Ocean; the Yellowstone and Cheyenne in the north and northeast, with numerous tributaries all of which reach the Missouri.

**Soils.** These change rapidly from the mountains to the plains. Near the mountains, in many areas, are gravelly soils, shading off to light, sandy ones; in other sections, heavy clay or gumbo soils are encountered. In the southwest is an arid, alkali region known as the Red Desert, suitable, for the most part, only for grazing. Along the water courses there is more humus usually, and irrigation brings good returns, even on the mesas. The mesa soils are mostly sandy or gravelly loams. Along the eastern edge of the Rockies, the soils are usually light loam, and respond well to dry-farming.

**Climate.** This is generally healthful on account of the dryness of the atmosphere, though subject to great extremes of temperature between day and night. The highest recorded temperature is 110 degrees, the lowest, 51 degrees below zero. The average annual temperature of the state is about 44 degrees, though different stations show average temperatures ranging from 32 degrees to 50.9 degrees. The rainfall is light, but varies widely in different sections, ranging from 5 inches or less in the Red Desert to 12 to 20 inches in the northeast, with still higher rainfall in the mountains. The snowfall is usually not heavy except in the mountains, and the heavy snowfalls there furnish abundance of water for irrigation. The climate is such that the native grasses cure on the range and can be grazed generally during the winter. The southwestern part is not subject to severe storms, but the region east of the mountains is in the storm track from the northwest, and is subject to cold waves and severe storms, though these are usually of short duration. In some sections, frosts are liable to occur during any month, but in others a frost-free season of 120 days is expected.

**Opportunities.** Considerable public land suitable for agriculture is still open to homestead entry. Land offices are located at Buffalo, Lander, Douglas and Cheyenne. There are a number of large irrigation projects both private and under the Federal Government, which together have hundreds of thousands of acres not yet taken. Some of these are open either for sale or rent, or the land may be leased for small payments with the privilege of buying. Irrigation ditches extend to the various sections. Information about irrigated lands may be obtained from the Reclamation Service, Department of the Interior, Washington, D. C.

**Products and industries.** Probably Wyoming is the least developed agriculturally of any state. Irrigation is necessary for the pro-

duction of most crops, and grazing has been the chief agricultural industry. The leading grain is oats, which exceeds in value any other cereal. Wheat ranks next. Hay and forage exceed in value any of the grains. Vegetables and fruits are little grown except for home use or local markets. Livestock is the great source of income for the rancher. Sheep are far in the lead of all other animals in number and value. Cattle and horses come next. Leading minerals are coal, oil and copper. Manufacturing has been little developed, main lines being lumber and timber products, and flour and grist-mill products.

**Transportation and markets.** Railway communication is confined mostly to the transcontinental lines. River transportation is unimportant.

**History.** Fur traders visited this region before the middle of the eighteenth century, but it was not till 1824 that the region of the Green and Sweetwater Rivers was explored by William Ashley, of the North American Fur Company, with a band of 300 men. John Colter, the first American visitor, spent the winter of 1806–7 on Pryor's Peak, and discovered Shoshone Lake and the Yellowstone country. Captain Bonneville and General Fremont, in 1832 and 1842 respectively, were the first explorers whose discoveries were recorded at length. The first white settlement was at the present site of Fort Laramie in 1834. There had been no permanent settlement and little development prior to 1867, but the discovery of coal and gold and the completion of the Union Pacific Railroad, encouraged immigration. The Territory of Wyoming was organized July 25, 1868, from portions of Utah, Dakota and Idaho territories, and it became a state July 10, 1890. The early history of the territory was marked by serious and prolonged troubles with the Indians. The Yellowstone Park was set aside by Congress in 1872 as a public reservation. The state constitution, adopted in 1869, contained a clause permitting woman suffrage which was a continuation of a territorial law.

**Agricultural organization.** College of Agriculture and Experiment Station (parts of the State University); and Coöperative Demonstration Work, *Laramie*. Commissioner of Public Lands, and Wyoming Farm Board, which has charge of a series of farms over the state, *Cheyenne*. The State Fair is held annually at *Douglas*. Information relative to agriculture and stock raising may be obtained from the Director of the Agricultural Experiment Station, *Laramie*.

The Director of the Experiment Station reports that a very rapid increase in agriculture has been made in the last 10 years. Sheep raising has increased rapidly, while cattle raising has decreased slightly, due to the public lands being cut up by the entry of homesteaders. Sugar-beet factories have been located at Sheridan and Lovell, and other factories have been projected, but for the most part, the agriculture of the state has been mainly along the lines of alfalfa and grain growing. It is the first aim of the settlers to grow cash crops, and such extensive agriculture as beet growing is not usually satisfactory until after the land has been worked for several years for other crops. New settlers always aim to get their land into alfalfa, provided it is under irrigation, as quickly as possible, for the lands of the arid region are usually lacking in humus and nitrogen, while other plant foods are present in abundance. The alfalfa roots and the green plants, when plowed under, make up this deficiency, and prepare the land for other crops.

## Statistics

### 1. Farms and Farm Property, 1920 and *1910*

| | |
|---|---|
| Population | 194,402; *145,965* |
| City | 57,348 (29.5%); *43,221 (29.6%)* |
| Country | 137,054 (70.5%); *102,744 (70.4%)* |
| Number of farmers | 15,748; *10,987* |
| White | 15,579 (98.9%); *10,922 (99.4%)* |
| Non-white | 169 (1.1%); *65 (.6%)* |
| Land area, acres | 62,460,160 |
| Acres in farms | 11,809,351; *8,543,010* |
| Acres farm land improved | 2,102,005; *1,256,160* |
| Average acres per farm | 749.8 (133 impr.); *777.6 (114.3* impr.) |
| Farm land artificially drained, acres | 35,654 (1.7% impr. farm land) |
| Farm land needing drainage, acres | 69,066 (.6% all farm land) |
| Farms by size, number: | |
| Up to 19 acres | 196; *420* |
| 20 " 49 " | 399; *338* |
| 50 " 99 " | 994; *645* |
| 100 " 174 " | 2,551; *3,816* |
| 175 " 499 " | 6,011; *3,629* |
| Over 500 " | 5,597; *2,139* |
| Value all farm property | $334,410,590; *$167,189,081* |
| Per cent increase in ten years | 100; *147.8* |
| Value farm land | $120,947,494; *$88,908,276* |
| " " buildings | $23,800,631; *9,007,001* |
| " " implements | $11,777,949; *$3,668,294* |
| " " livestock | $87,884,516; *$65,605,510* |
| Av. value all property per farm | $21,235; *$15,217* |
| " " land and buildings per acre | $19.88; *$11.46* |
| Number farms run by owners | 13,403 (86.3%); *9,779* (89%) |
| Number farms run by tenants | 1,968 (12.5%); *897 (8.2%)* |
| Per cent owned farms unmortgaged | 50.9; *79.9* |
| Per cent farms reporting automobiles 39.2; telephones 28.3 | |

### 2. Crop Acreages, Yields, Values, 1919 and *1909*

| | | |
|---|---|---|
| Value all farm crops | $30,270,630; | *$9,903,071* |
| " " cereals | $5,412,775; | *$2,744,502* |
| Corn, acreage | 38,575; | *9,268* |
| production (bu.) | 388,512; | *176,354* |
| 10-yr. av. yield per acre | | 22.4 bu. |
| Wheat, acres | 181,420; | *41,968* |
| production (bu.) | 1,445,227; | *738,698* |
| 10-yr. av. yield per acre | | 23.2 bu. |
| Oats, acres | 58,622; | *124,035* |
| production (bu.) | 1,006,552; | *3,361,425* |
| 10-yr. av. yield per acre | | 35.9 bu. |
| Rye, acres | 41,879; | *1,516* |
| production (bu.) | 192,532; | *20,479* |
| 10-yr. av. yield per acre | | 17 bu. |
| Barley, acres | 7,970; | 8,*561* |
| production (bu.) | 115,624; | *189,057* |
| 10-yr. av. yield per acre | | 32.4 bu. |
| Hay and forage, acres | 832,482; | *585,386* |
| production (tons) | 907,287; | *853,515* |
| value | $20,612,504; | *$6,079,923* |

| | | |
|---|---|---|
| Potatoes, white, acres | 11,791; | *8,333* |
| production (bu.) | 851,253; | *932,162* |
| 10-yr. av. yield per acre | 122 bu. | |
| Sugar beets, acres | 9,935; | *1,181* |
| production (tons) | 96,994; | *13,234* |
| Small fruits, acres | 87; | *106* |
| production (quarts) | 56,824; | *96,883* |
| Strawberries, acres | 39; | *24* |
| production (quarts) | 27,061; | *20,895* |
| Vegetables, acres 582; value | $2,727,416; | *$856,639* |
| Apples, production (bu.) | 29,999; | *17,836* |
| Pears, production (bu.) | 64; | *16* |
| Peaches, production (bu.) | 4; | *5* |
| Plums and prunes (bu.) | 3,091; | *659* |
| Grapes, production (lbs.) | 12; | *159* |
| Forest products, value | $156,837; | *$104,259* |

Nurseries: 8 acres in 4 establishments; receipts $1,025
Greenhouses: sq. ft. under glass..................43,056
" receipts...........................$21,217

### 3. Livestock, 1920 and *1910*

| | | |
|---|---|---|
| Number farms reporting livestock | 14,622; | pure breds 2,655 |
| Value all livestock on farms | $87,884,516; | *$65,605,510* |
| Horses, number | 198,295; | *156,062* |
| value | $11,281,294; | *$12,426,838* |
| Mules, number | 3,415; | *2,045* |
| value | $342,241; | *$248,572* |
| All cattle, number | 875,433; | *767,427* |
| value | $50,012,404; | *$22,697,387* |
| Beef cattle, number | 817,241; | |
| Dairy cattle, number | 58,192; | *32,699* |
| Sheep, number | 1,859,775; | *5,397,161* |
| value | $24,250,274; | *$29,666,228* |
| Goats, number | 1,511; | *2,739* |
| value | $9,341; | *$16,128* |
| Swine, number | 72,233; | *33,947* |
| value | $1,174,580; | *$301,716* |
| Poultry, number | 646,357; | *341,050* |
| value | $634,793; | *$194,078* |
| Bees, number of hives | 13,968; | *4,596* |
| Livestock, products value | $14,004,109; | *$10,234,548* |
| Value all dairy products | $2,143,020; | *$539,423* |
| " eggs and chickens | $2,021,979; | *$761,924* |
| " wool and mohair | $9,574,466; | *$8,916,576* |
| " honey and wax | $264,644; | *$16,725* |
| Milk produced (gals.) | 14,542,841; | *6,453,634* |
| Butter made (lbs.) | 1,422,822; | *1,192,122* |
| Eggs produced (dozens) | 3,165,743; | *2,070,799* |

### 4. Irrigation, 1920 and *1910*

| | | |
|---|---|---|
| Acres in irrigated projects | 2,564,668; | *2,224,298* |
| " of projects irrigable | 1,831,039; | *1,639,510* |
| " " " irrigated | 1,207,982; | *1,133,302* |
| " " irrigated land open to settlement | 197,326 | |
| Capital invested in projects | $34,326,328; | *$17,700,980* |
| Average investment, per acre | $18.75; | *$10.80* |
| Estimated final cost | $51,500,288; | *$20,425,890* |
| Average cost per acre | $20.08; | *$9.18* |
| Average cost maintenance and operation, per acre | $1.04; | *$0.86* |
| Acres of crops on irrigated land | 509,945 | |
| Value of crops on irrigated land | $15,683,997 | |
| Av. value crops on irrigated land, per acre (1919), | $38.76 | |

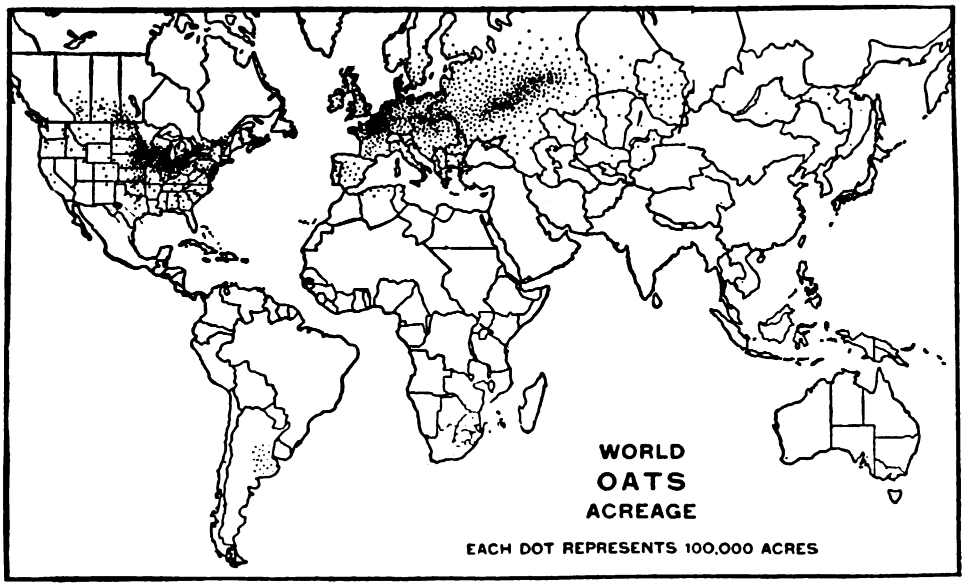



FIG. 378. Oats are clearly a crop for temperate to cool climates. In Europe they represent an important source of human food; in America their greatest use is as feed for livestock, particularly horses. (1916 Yearbook, U. S. Department of Agriculture.)

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